SIXTH REPORT OF

THE BUREAU OF MINES

1896.

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To His Honor GEORGE AIREY KIRKPATRICK,

Lieutenant-Governor of Ontario

I have the honor to transmit herewith, for presentation to the Legislative Assembly, the Sixth Report of the Bureau of Mines.

I have the honor to be, Sir,

Your obedient servant,

J. M. GIBSON,

Commissioner of Crown Lands.

DEPARTMENT OF CROWN LANDS,

Toronto, April 7, 1897.

SIXTH REPORT OF

THE BUREAU OF MINES.

To the Honorable JOHN M. GIBSON,
Commissioner of Crown Lands:

SIR,—I am submitting herewith, for presentation to His Honor the Lieutenant-Governor, the Sixth Report of the Bureau of Mines.

The mining industry in Ontario has made a distinct advance during the past year, although it is too early yet for the progress to be measured by statistics of production. State of the mining industry.

Activity is evinced mostly in three ways: first, by the applications made for mining lands; secondly, by the extent of development work undertaken; and thirdly, by the number of companies organized to carry on mining operations. Evidence of activity.

Compared with the transactions in mineral lands in 1894, there was an increase last year in the number of locations sold and leased of 218, in the areas of lands sold and leased of 13,635 acres, and in the receipts from sales and rentals of $22,644. The total collections on account of lands sold and leased last year was $35,581 (not including $5,006 of rent money paid on lands previously leased), and during the last few weeks of the year there was paid in a further sum on lands applied for of $28,436. The largest receipts were in the months of November and December; and as evidence of the continued briskness of operations, it may be stated that the receipts on account of mining lands in the first three months of the present year, exclusive of a special deposit of $20,000, have been $72,387. These figures relate to transactions in Crown lands only. There have been large investments in patented lands, but no attempt has been made to procure a list of them. Transactions in mineral lands.

The efforts of miners and capitalists have been directed largely to proving the worth of gold properties. There are only a few gold mines in the Province where development work has been carried on far enough to keep mills running steadily; and although the same ill-advised course has been pursued here as in every other new gold country, of building mills before it was proven that there was ore of a quantity and value to pay for raising and treating it, or before the workings were on a sufficient scale for economic mining, the direction in which enterprise has been moving during the past year indicates the Development work.

adoption of a safer and more intelligent method. Along the Seine river, around Lake of the Woods, and upon Eagle, Wabigoon and Manitou lakes, as well as in two or three other localities farther east, many properties have been explored with trenches, cross cuttings and shafts, and as a result of work so done several mills will be built this year. Upon one property on the Shoal lake of Seine river prospecting and mining had been carried on for more than a year before steps were taken to supply a mill, and when the machinery driving twenty stamps was set in motion a few weeks ago it was estimated that the mine showed two years supply of ore in sight. Large numbers of men were employed at work of this kind last year, and many thousands of dollars were paid out of capital for labor, supplies and prospecting machinery, and wherever gold-bearing veins are proven to be rich and strong, means will doubtless be found to mine and mill the ores. Expenditure for development will not only prove what properties are valuable, but will make possible the production of ores at low cost and in ample quantity when mills are built.

Investment of capital.

Until very recently few companies had been organized in the Province to carry on mining operations. Some were working under foreign charters, but of these the number actually engaged in the industry did not exceed half a dozen. In 1894, the first year in which mining corporations were empowered to sell stock at any fixed price above or below par, only five charters were granted under the Ontario Joint Stock Companies' Act, and the aggregate of their authorized capital was only $2,170,000. Under the same Act in 1896 the number formed was 22, with an authorized capital of $12,775,000; and the charters to 12 of these, representing an aggregate capital of $9,475,000, were granted during the months of November and December. In the first quarter of the present year however the record of 1896 has been far surpassed, 33 mining companies having been organized and chartered with a total authorized capital of $22,665,000. These facts furnish clear evidence of the advance that has been made in the mining affairs of the Province, and of preparation for greater activity in the near future. They are evidence, too, of the confidence that has been established in the mineral resources of our Province, in the face of a shrinkage of £79,220,000 or about 65 per cent. in the market valuation of the stocks of forty-one South African companies during the past year.

Statistics of the Report.

The Report gives statistics of the areas of and moneys received for lands sold and leased during the calendar year, as well as statistics of the quantity and value of the mineral products of the Province, and of the labor each branch of the industry employs.

Building materials.

In building materials there is a noticeable decrease, as a result of the slackness in building operations throughout the country during recent years.

The production of gold bullion has been considerably increased, but encouragement lies rather in the extent and promise of development work going on than in the yield of the one or two mills steadily supplied with ore. Gold.

The nickel and copper mines and works gave employment last year to nearly the same number of men as in the previous year, and although only two companies were carrying on business the output was not much less than when there were four. Experiments with new processes to treat the ores and refine the metals continue to be made, and confidence is expressed that by the use of improved methods separation of the metals will be simplified and cheapened. The value of nickel as an alloy is now so well established that the demand for it is certain to increase with every step made in lowering the cost of production. Nickel and copper.

The petroleum statistics do not show marked change from those of former years, but prices for crude have been well maintained. The reopening of the Bothwell field during the year promises to add substantially to the output of the wells, but as far as exploration work has been carried on there it does not appear that the productive area of this once famous region is large. The borings on Pelee island only serve to show that oil bearing rock exists there; its area and richness remain to be proven. The gas fields of Essex and Welland maintain their output, more especially the former; but the bulk of the natural gas is taken for consumption by the cities of Detroit and Buffalo. Petroleum.

The gypsum mines and works and the salt works continue to be conducted upon a moderate scale to supply the home market; hardly an attempt is made to produce for export, as the United States is practically the only available market, and the duty on salt entering that country is prohibitory. One plant has been completed in connection with the Ontario People's salt works at Kincardine for the manufacture of bicarbonate of soda, which should prove to be an industry capable of large expansion. Gypsum and salt.

The production of natural rock and Portland cements is well maintained as compared with previous years; but while the makers of Portland cement have been steadily increasing the output of their works, and improving the quality of the cement, they are far from being able to supply the requirements of the country. The raw materials for Portland cement are so plentiful in Ontario that we might be making largely for the export trade instead of importing for consumption. Cements.

Some smaller industries were started in the Province during 1896 which are well deserving of mention, for they promise to become important. The blast furnace at Hamilton, which started up its first campaign early in the year, produced a total of 28,302 net tons of pig iron. A graphite mill erected at Ottawa for treating the ores from a large vein of the mineral discovered in Pig iron, graphite

and carbide of calcium.

Brougham township has commenced to run under very favorable auspices and substantial orders for the refined graphite have been received from Germany. The works at Merritton for the manufacture of carbide of calcium have been successfully inaugurated, and their capacity has been gradually enlarged. A leading English journal published in the interests of the chemical and metallurgical trades, which two years ago regarded the claims of calcium carbide for economic production of light and heat with grave suspicion, says in a recent issue that very great attention is now being given to it, especially in Europe, that new variations in the process of manufacture are being suggested and patented almost daily, and "the signs are visible that within comparatively a short period we shall see an enormous extension in this incipient industry." The company formed to manufacture peat fuel in the county of Welland has been employed during a portion of the year in the production of moss litter for the American markets under a contract for large quantities extending over a period of years, and the manager is sanguine that this year they will begin at the same place the production of peat fuel.

Papers constituting the Report.

Among the papers which constitute this Report are: Dr. A. P. Coleman's third report on the West Ontario Gold Regions; Notes on the Milling of Gold Ores, by John E. Hardman of Montreal; the Story of Silver Islet, by the writer; Notes on Moss Litter, by Thomas W. Gibson, Secretary of the Bureau; Explorations on the boundary between Nipissing and Algoma, by E. M. Burwash, B.A., of Victoria College; and a Descriptive Catalogue of Mineral Collections for the Summer Mining Schools, by Prof. Goodwin and his associates of the Kingston School of Mining; and the seventh annual report of the Inspector of Mines, Mr. Aaron Slaght of Waterford.

Maps

The maps accompanying the Report have been prepared under the supervision of Dr. George M. Dawson, Director of the Geological Survey of Canada at Ottawa. The latest surveys of townships and mining locations have been laid down upon them from plans, field notes and maps supplied by Mr. G. B. Kirkpatrick, Director of Surveys of the Crown Lands Department here. The smaller of the two is known as the Shebandowan sheet, embracing the country from Port Arthur to the west line of Moss township; the larger embraces the north half of Lake of the Woods.

I have the honour to be, Sir,

Your obedient servant,

ARCHIBALD BLUE,

Director.

OFFICE OF THE BUREAU OF MINES,
Toronto, April 7, 1897.

[1] Industries and Iron, March 26, 1897.

SECTION I.

GENERAL INTRODUCTION.

Evidences of progress in mining enterprise in Ontario.

The past year furnishes proofs of a steadily growing interest in mining affairs throughout the Province. The prospectors, who are everywhere the pioneers of the mining industry, were busily employed exploring the wilderness to the close of the year, regardless of the heat of summer and the rigors of winter. Owners of mining locations, too, were more eager than ever hitherto to show up the value of their properties by development work. There was also apparent a greater readiness to make investments, and during the latter part of the year the pages of the Official Gazette were crowded with notices for the incorporation of mining companies. The list following gives the names of the several companies to which charters were issued, the dates of incorporation and the amounts of authorized capital:

Incorporation of mining companies.

Names of Companies.	Date.	Capital.
The Algoma Copper Mining Company, Limited	31st March	$ 1,000,000
The Algoma Coal Mining Company, Limited	30th December	1,000,000
The Credit Forks Mining and Manufacturing Company, Limited	14th February	200,000
The Empress Gold Mining Company of Ontario, Limited	7th February	100,000
The Foley Mines Company of Ontario, Limited	25th November	1,000,000
The Great Northern Mining, Exploration and Development Corporation of Ontario, Limited	2nd December	475,000
The Golden Fissure Mining Company of Ontario, Limited	24th December	1,000,000
The Heather Bell Gold Mining Company of Toronto, Limited	6th November	1,000,000
The Lake Harold Gold Mines Company, Limited	12th June	150,000
The Lake Harold Gold Mines Company, Limited	9th December	1,000,000
The Ontario Mines Development Company, Limited	30th October	50,000
The Princess Gold Mining Company of Ontario, Limited	21st October	500,000
The Preston Gold Mining Company of Seine River, Limited	4th November	50,000
The Rainy River Mining Company, Limited	4th November	1,000,000
The Saw Bill Lake Gold Mining Company, Limited	26th May	100,000
The Seine Manitou Gold Mining Company, Limited	9th September	100,000
The Standard Mining and Development Company of Ontario, Limited	24th December	500,000
The Trill Mining and Manufacturing Company, Limited	7th July	1,000,000
The Temiscamingue Lithographic Stone and Mining Company, Limited	20th March	100,000
The Victoria Mining Company of Ontario, Limited	2nd December	450,000
The Western Ontario Mining Company, Limited	18th November	1,000,000
The Yum Yum Gold Mining Company of Ottawa, Limited	24th December	1,000,000

The total amount of authorized capital is $12,775,000, and all excepting five or six of the twenty-two companies incorporated have been organized to carry on operations in the gold fields of the Province—prospecting developing and mining. Besides these, there are companies formed under the Imperial Joint Stock Companies Acts, one or two of which brought in large sums of money to spend in opening mines and the erection of works to treat ores.

The safe-guarding of investments.

Many people of small means have been led to invest their savings, and, towards the end of the year, there was a rush for shares in all kinds of mining companies in and out of the Province, some of which were of more than doubtful substantiality. Fortunately the excitement did not reach a serious stage, and, under the new statute of the Legislature for the regulation of extra-Provincial companies, the promoters of "wild-cat" schemes will find that before stocks are sold in the money markets here some better assurance of their worth must be given than a gilded advertisement in a newspaper. Mining stocks may be as safe as stocks of any other kind, yet experience everywhere shows that there is a temptation to exaggerate their value, and that gold stocks especially have a glamour to draw the unwary. It is not the wealthy classes in England as a rule that buy mining shares, and those who have suffered most severely from the drop in South African stocks are ones who could least afford it. There is great need of capital in this country to build up mining; but the earnings of one industry should not be squandered in another, and prudent measures of legislation skilfully administered may give valuable service in even so delicate a matter as the investment of capital, especially when the business is in a far-off field and carried on under other laws than our own.

Exploration of the mineral regions of Ontario.

The great expanse of the mineral bearing formations of Ontario makes it certain that many years must elapse before the extent of its mineral wealth is known. Only a fraction of the whole area has yet been covered by the labors of the explorer, whose efforts are circumscribed by the want of means to go beyond the limits of the most accessible regions. It appeared to be desirable therefore to try some other plan for furthering enterprise, if thereby there was a prospect of attracting outside capital. An opportunity of this kind was presented last summer, when a proposal came from an English syndicate to explore one or two tracts of limited area concerning which nothing was then known, and to provide capital for working mineral deposits in them should any be discovered. At that time, when South Africa was being shunned, and British capital was flowing into British Columbia and other new channels, such a proposal presented merits of exceptional value, and the terms agreed upon between the Government and the English parties have been ratified by the Legislature. One of the tracts granted under a license of occupation lies on the west side of Lake of the Woods, while the other is north of Rainy lake, the two having an aggregate land area of 46,000 acres. The license is for a period of three years from the first of May in this year, and under the terms the licensees are required to expend in actual exploration, development and mining upon the lands during the first year $30,000, during the second $40,000, and during the third $50,000, being in all $120,000; and, by way of security to carry on the exploration, a deposit of $20,000 has been made to the credit of the Commissioner of Crown Lands, which is absolutely forfeitable in default of such expenditure. In the event of valuable minerals being discovered on the tracts, locations may be granted to the licensees in parcels to be selected during the three years, upon the usual terms of sale or lease as provided in the Mines Act, and subject to all other conditions of the Act as to development and other

Agreement with an English syndicate to explore under license of occupation.

wise. For the purpose of exploring these concessions, a company has been incorporated in London under authority of the Imperial Companies Acts, 1862 to 1890, and with the title of the Ontario Government Gold Concessions, Limited, with a capital of £80,000 stg, which has for its directors the Hon. C. M. Knatchbull Hugesson, James Reid, formerly of Toronto, and Edward M. Bovill. The shareholders are well known capitalists of London, nearly all of whom are reputed to be millionaires. Should their venture prove to be successful it will no doubt lead to other and much larger investments of British capital in Ontario. The result of the explorations, as well as of the experiment itself, will be awaited with interest and hope.

"The Ontario Government Gold Concessions, Limited."

Government roads to aid the mining industry.

Nearly all the mining regions of the Province are far removed from the older settlements, and therefore are out of reach of the ordinary highways of travel and traffic. It is an expensive business to build roads into a mining country under any circumstances, as a rule, since it usually abounds with rocks and is often broken by lines of rocky hills or low mountains. Rivers and lakes are frequent also, and to cross the one or get around the other adds much to the cost of road-building. Then, too, it is inevitable that in a country where the mining industry is in the early stages, one road may have to be constructed a number of miles to serve only one or two mines, so that the cost may seem to be largely out of proportion to the service. Yet the Government has not been unmindful of the necessities of the miner, as the following record of twelve years will serve to show.

From 1885 to 1893, or during the period of operating the silver mines in the townships of Gillies, Lybster and Strange, west of Fort William, there was expended on a main road from Oliver township to Whitefish lake and on branch roads to the mines, including a bridge on the Kaministiquia river, $43,423 ; while in the latter part of the same period $2,168 was spent in building a road to mining properties in Dorion township, east of Port Arthur. In the four years 1891-94 roads and bridges leading out to mines and mining properties were built in the Sudbury district, between Wahnapitae and Larchwood, at a cost of $9,723. These include the Wahnapitae and Larchwood roads, roads into Fairbank and Trill townships, and a bridge on Vermilion river. In 1887 a road was built from Baril portage 14 miles south into the township of Moss, to serve the Huronian gold mine, which cost $8,456. In 1889 the first road in the Lake of the Woods region extending out towards mining locations was built from Rat Portage to Matheson's bay, which is the winter road to the Sultana mine. The work cost $2,200. Nothing further was done in northwestern Ontario until 1894, when the region began to be actively prospected, and since that time several important works have been undertaken. Among these are the Rossland road, east from Rat Portage; the Shoal lake and Bad Vermilion road, north from the Seine river ; a trail of 35 miles from Sand lake on the Port Arthur, Duluth and Western Railway to Hart river, which empties into Kawawiagamog lake ; a trail of 65 miles from Ignace station on the Canadian Pacific Railway to Sturgeon Falls on the Seine river ; the cutting out of 26 portages on the Atik-okan and Seine rivers, an important canoe route to the gold fields ; a road from Jackfish bay on lake Superior towards Long lake, to serve the Empress mine and

other properties; a trail from Minnehaha lake to Manitou lake; a trail and portage from Red Paint lake towards Sawbill lake; and what is known as the Bigsby island and Rat Portage road,—costing altogether $4,713.

The total expenditure by the Government in the northern districts for roads to facilitate mining enterprise during the twelve years 1885-96 has been $70,683. For the year 1897 the Legislature has made appropriations for mining roads which aggregate $35,600, or half as much for one year as the whole expenditure for the past twelve years.

SALE AND LEASE OF MINING LANDS.

The number of patents issued in the Province last year for mining lands, the acreage of locations and the price paid to the Treasury therefor, are presented in the following table:

Mining lands patented in 1896.

Districts.	No. of patents.	Acres.	$ c.
Rainy River	129	9,295½	19,073 30
Thunder Bay	4	463	1,138 00
Algoma	1	140	420 00
Elsewhere	6	835	1,452 50
Totals	140	10,733½	22,083 80

In 1895 three-fourths of all the patents were issued for locations taken up in the Rainy River district, and last year all but one-fourteenth of the whole are credited to the same district. These lands are almost altogether in the gold producing regions, and as a result of some very promising development work the rush for locations in the last two months of the year was so great as to overtax the powers of the Department to deal with them. The number of patents issued was 41 more than in the previous year, the area of lands sold more by 3,033½ acres, and the price paid more by $6,215.80. The average area of locations sold last year was 76.67 acres, whereas in 1895 it was 65 62 acres and in 1894, 58.71 acres.

The next table gives by districts the number and acreage of mining lands leased during the year, and the amount of the first year's rental paid therefor

Mining lands leased in 1896.

Districts.	No. of leases.	Acres.	$ c.
Rainy River	150	12,392¼	12,753 04
Thunder Bay	8	675¼	675 25
Elsewhere	3	156	69 35
Totals	161	13,223½	13,497 64

All but a sixteenth of the locations leased were taken up in the Rainy River district; but the whole number is 14 less than in the preceding year, while the area is less by 1,860½ acres and the rental less by $426.36. The rental paid in on lands previously leased was $5,006.55, being $1,719.34 more than

in the previous year. The total receipts from sales and rentals last year was $40,587.99, as against $34,079.16 in 1895, and $17,942.56 in 1894.

Comparative statistics of the sales and rentals of mining lands are furnished by the next table for the five years 1892-6 :

Year.	[illegible]			Locations leased.			Rental of lands previously leased.
	No.	Acres.	$	No.	Acres.	$ c.	
1892 ...	65	6,200	15,273	95	13,122½	12,314 36	603 00
1893 ...	63	4,370	11,489	122	13,046¾	11,933 90	2,735 86
1894 ..	40	3,271	7,646	66	7,050½	6,488 78	3,807 78
1895....	99	7,720	15,868	175	15,084	14,924 00	3,287 16
1896....	140	10,733½	22,084	161	13,223½	13,497 64	5,006 50
Totals.	407	32,294½	72,360	619	61,527¼	59,158 68	15,440 30

Comparative statistics of the five years 1892-6.

The total number of locations sold and leased as mining lands in the five years is 1,026, the area 93,821¾ acres, and the revenue from sales and rentals $146,958.98. For the first three months of the present year the amount paid into the Treasury for mining lands is $72,387, or nearly half as much as the receipts of the five years.

BUILDING MATERIALS.

No improvement is yet noticeable in the production of building materials. On the contrary, the returns made to the Bureau show that the output of the various classes of works is steadily diminishing, and that large numbers of establishments throughout the country are standing idle for want of a market. Indeed it is becoming increasingly difficult to procure satisfactory returns of any of the works employed in the manufacture of building materials.

The following table presents the statistics of the stone quarries for the six years 1891-96 :

Year.	Value.	Wages.
	$	$
1891	1,000,000	520,000
1892	880,000	730,000
1893	721,000	464,000
1894	554,370	336,700
1895	438,000	296,000
1896	394,000	273,000

Statistics of building stone, rubble, etc.

"No work done during the year" is a remark accompanying many of the returns, and it is apparent that the business depression has told heavily against the owners of stone quarries and the workmen who seek employment in the quarries.

The brick yards and tile yards of the Province have a like tale to tell, as the following table of production for the same period of years too clearly shows:

Statistics of common brick and drain tile for 1891-96.

Year.	Brick, M.	Value.	Tile, M.	Value.	Wages.
		$		$	$
1891	160,000	950,000	7,500	90,000	432,000
1892	175,000	980,000	10,000	100,000	445,000
1893	162,350	932,500	17,300	190,000	451,000
1894	131,500	690,000	25,000	280,000	388,000
1895	126,245	705,000	14,330	157,000	364,000
1896.........	105,000	577,000	13,200	144,000	306,000

Pressed brick, roofing tile and terra cotta statistics are given in the next table:

Pressed brick, o and terra cotta

Year.	Number.	Value.	Wages.
		$	$
1891	13,617,909	156,699	58,000
1892	22,048,000	259,335	88,865
1893	21,634,000	217,373	80,686
1894	25,456,000	286,230	95,400
1895	17,940,867	184,550	69,442
1896	12,201,000	129,845	60,824

Pressed brick is used for the more costly structures, but notwithstanding the excellence of the quality produced in the Province it is obvious that for the present the demand for it is falling off. When business revives, however, there is not much doubt but pressed brick will come extensively into use. It may be observed that terra cotta includes the porous variety, used in the construction of fire-proof buildings.

The statistics of lime are of the same general character as those of other building materials. The following table gives quantities, value and wages paid for labor for each of the six years 1891-96:

Statistics of lime production for 1891-96.

Year.	Bushels.	Value.	Wages.
		$	$
1891	2,350,000	300,000	116,000
1892	2,600,000	350,000	120,000
1893	2,700,000	364,000	122,000
1894	2,150,000	28[illegible],000	108,000
1895	2,090,000	280.000	104,000
1896	1,880,000	220,000	85,000

Better times will no doubt come to the producers of building materials when business revives.

SUMMARY OF MINERAL PRODUCTION.

Quantity and value of mineral production in 1896, with number of workmen employed and amount of wages paid for labor.

Product.	Quantity.	Value.	Employes.	Wages.
		$		$
Building stone, rubble, etc	....	394,000	780	273,000
Cement, natural rock ....barrels	60,705	44,100	56	15,200
Cement, Portland .... "	77,760	138,230	120	48,400
Lime ....bushels.	1,880,000	220,000	430	85,000
Drain tile . ...number.	13,200,000	144,000	1,850	306,000
Common brick......... "	105,000,000	577,000		
Pressed brick, plain.... "	10,774,400	88,945	180	60,824
Pressed brick, fancy ... "	1,256,600	9,910		
Roofing tile	170,000	6,800		
Terra-cotta	....	24,190		
Sewer pipe	....	49,875	41	17,774
Pottery	....	104,000	128	39,000
Petroleum ....imperial gallons.	27,380,588	. . ..	....	....
Illuminating oil "	11,342,880	1,263,230	351	190,740
Lubricating oil "	2,283,047	204,946		
All other oils "	7,821,262	340,054		
Paraffin wax .... lb.	1,532,671	76,250		
Fuel product	.. . .	70,815		
Natural gas	.. ..	276,710	87	47,527
Salt .... tons.[1]	44,816	204,910	173	50,650
Gypsum .... "	3,500	10,500	....	....
Calcined plaster .... "	700	10,250	....	....
Graphite .... "	650	13,000	15	2,250
Iron .... "	28,302	353,780	125	47,000
Nickel .... "	1,948½	357,000	485	247,151
Copper .... "	1,868	130,660		
Gold . ... oz.	7,154	121,848	189	91,210
Totals...........	....	5,235,003	5,010	1,521,726

[1] Net tons of 2,000 lb.

VITRIFIED BRICK FOR STREET PAVING.

Qualities of vitrified brick as pavement material.

The use of vitrified brick for street paving purposes in Ontario is still practically confined to the city of Toronto, where its admirable qualities as street material are bringing about its adoption on a considerable scale. The cleanliness and smoothness of brick pavements, their freedom from objections in a sanitary point of view, and their durability when made of tough, non-absorbent and well-burned brick, are recommendations which cannot be overlooked when choice is to be made of paving material. The more general introduction of vitrified brick is hampered to some degree by the cost of such pavements here as compared with their cost in the United States. In the latter country brick can be bought at works of wide repute at $8 per thousand, whereas the cost of such brick laid down in Toronto, with freight and duty added, is little if at all short of $16 per thousand. Native Canadian brick are now being made and placed on the market, but in the face of a very active demand and as yet little competition among manufacturers, it is not surprising to find that the cost is about $14 per thousand—just sufficiently below the price of foreign brick to prevent its importation. It may be expected that as the industry takes root and thrives, the working of the law of supply and demand and the increased skill and experience of manufacturers will permit of a reduction in price to somewhere near the American level. It is to be borne in mind however that the manufacture of paving brick is an industry which calls for the expenditure of a large amount of capital in the erection of plant, and frequently also for the outlay of no small sum by way of experimental treatment of clays in order to ascertain the best mixtures etc. Another item of expense which is heavier in Ontario than in the United States is the cost of coal, which must be brought from the latter country, and is dearer by at least the charges for freight and duty.

Relative cost of block and brick pavements.

The large area of cedar-block pavements in Toronto which are falling, and in many cases have already fallen, into decay, demands renewal with material of some kind. Cedar blocks have deservedly gone out of favor, their sole recommendation being the cheapness with which they can be laid down. So much have materials and labor fallen in cost that block pavements can now be constructed for 40 or 45 cents per square yard on a foundation of sand or gravel, or $1 25 per square yard on concrete. The cost of brick pavement on concrete is about $1.60 per square yard, yet notwithstanding the excess in cost in many cases of street renewal brick is preferred by the property owners to cedar blocks. In 1896 six streets were paved wholly or in part with brick, the total area being 13,756 square yards, at an average cost of $1.59 per square yard. The number of streets paved with asphalt was three, with cedar blocks three, with macadam five, and with brick on gravel one small section. In 1897 the prospects are that twelve or fourteen streets will be paved with brick. As in 1896, the streets are principally short residential ones. The bricks used were nearly all Ontario make, the product of the Ontario Paving Brick Company of Carlton, and of the Don Valley Pressed Brick Company of Toronto, principally the former, a short description of whose works was iven in the Report of the Bureau for 1895. The Don

Growing use of brick fer street construction.

Valley Company are now including paving brick among the many lines of clay goods which they manufacture, and the energy and resources of the company will doubtless enable them to take a leading place in the industry.

The bricks must be capable of standing the following tests prescribed by the city engineer: for absorption, a piece broken from the centre of any brick, not more than ¾-inch in thickness, and from 60 to 120 grammes in weight, is to be thoroughly dried and then immersed in water; after being in the water for six hours, the increase in weight must not exceed two per cent. For abrasion the test is as follows: Any three bricks when tumbled in an iron rattler, 24 inches in diameter by 36 inches in length, revolving at a rate of about 25 revolutions per minute, must not lose more than eight per cent. of their weight after 1,500, nor more than twelve per cent. after 3,000 revolutions. The rattler contains when making this test 200 lb. of cast iron, in 100 cubes (with the corners rounded to about ½-inch radius) weighing two pounds each. Tests prescribed for brick.

The supply of paving brick from the local works is quite unequal to the demand, and this inadequacy is calculated to decrease the rapidity at which the change from wooden block to vitrified brick pavements in Toronto might go on. Time and the enlargement of facilities for production by existing factories, or the establishment of new ones, will doubtless provide a remedy. Demand and supply.

As to the comparative merits of Canadian and American paving brick, experience with the native article has been too short to enable a final verdict to be given. It must be remembered that the first streets in Toronto to be laid with Ontario brick were paved in 1895, and that the time they have been in use has therefore not been sufficient to demonstrate their wearing qualities. It may be said however that so far their behavior has on the whole been satisfactory, and there is no reason to doubt that with increased knowledge of the raw material with which they have to deal, and increased experience in the process of manufacture, Ontario makers will be able to produce brick every whit as handsome and durable as their fellow manufacturers of Ohio or Illinois. Comparative merits of Canadian and American brick.

Certainly there is every reason for desiring to see the industry firmly established in the Province. It is one that places at the command of the public a paving material conferring all the benefits that follow in the train of smooth, solid and durable streets, and is calculated to add much to the appearance and healthfulness of our cities and towns, and consequently to the comfort of their inhabitants; while at the same time it is an industry which from its nature provides employment for a maximum of labor. The raw material, clay, possesses in itself comparatively little value, but the processes of manufacture are such as to call for a great deal of handling, and in the main by grown men, for wet clay and finished bricks are heavy articles, and require strength of muscle to move them. The clay must be dug, loaded into carts or cars, and unloaded at the grinders or dry pans, after which in a modern mill it is forwarded automatically as far as the cutting-off tables and press; then the green bricks must be wheeled into the drying chambers, afterwards piled in the burning kilns, and subsequently wheeled from the kilns to the stock piles. A very large part of the value of the finished article is An industry which deserves encouragement.

represented by labor, and a brickyard is no place for boys and girls. Many of the men are heads of families, and the value to a community of an industry which employs adult male labor almost wholly is much greater than that of one served for the most part by women or minors. Very few industries would give better or more profitable employment alike to native capital and labor than a well-established paying manufactory for the production of vitrified brick.

NATURAL ROCK AND PORTLAND CEMENTS.

The number of works employed in the manufacture of natural rock and Portland cements was the same in 1896 as in the previous year, but there is a satisfactory increase in the quantity and value of the products. Following are the statistics of this industry for the three years 1894-6:

Comparative statistics of three years.

Schedule.	1894.	1895.	1896.
Natural rock cement—			
Number of works...	5	5	5
Number of workmen	63	45	56
Wages for labor ....$	13,020	14,166	15,200
Product ....bbl.	55,323	65,219	60,705
Value of product ....$	48,774	45,145	44,100
Portland cement—			
Number of works......... ...	3	2	2
Number of workmen..........	105	129	120
Wages for labor ....$	31,858	46,000	48,400
Product ....bbl.	30,580	58,699	77,760
Value of product ....$	61,060	114,332	138,230

The increase has been much greater in Portland than in natural rock cement, the output of the former being 154 per cent. more in 1896 than in 1894, whereas that of the latter has been less than 10 per cent. The price is lower than in 1894, Portland cement having fallen from \$2 to \$1.77, and natural rock from 88 cents to 72½ cents per barrel. The quality of both kinds is well maintained, and the fact appears now to be generally admitted that the Portland cement compares very favorably with the best of the same class made in Europe. The manufacturers however are not yet able to meet the demands of the home market, for during the fiscal year ending June 30, 1896, Canada imported 210,095 barrels, valued in the Trade returns at \$255,029. But extensive additions are being made to at least one of the plants, and the output of Portland cement is likely to be very considerably increased this year.

PETROLEUM AND NATURAL GAS.

The activity that was apparent in the petroleum industry in 1896, as a consequence of the improved market for crude and its products, did not lead to any material increase of business last year—the reason being, as expressed by one of the leading refiners, that "tariff uncertainty retarded developments." The following tables give the statistics of the industry for the years 1895 and

Rock Dump of Copper Cliff Mine near Sudbury.

Roast Heaps at Copper Cliff Mine.

Rock House at Copper Cliff Mine.

1896, based on returns made to the Bureau by the five refining works, the quantities being imperial gallons. The first table gives the crude used or treated at the works in each year : Statistics of crude production in the years 1895-6.

Schedule.	1895	1896
Crude used for fuel, ... gal	2,213,639	2,221,349
Crude distilled, ... "	25,223,785	25,159,239
Total crude, ... "	27,437,424	27,380,588

The total value as crude is returned by the refineries at $1,230,764 for 1895 and $1,222,307 for 1896. Statistics of distilled products are given in the second table :

Statistics of refinery products in 1895-6.

Product.	1895		1896	
	Quantity.	Value.	Quantity.	Value.
		$		$
Illuminating oils, gal.	10,924,826	1,237,328	11,342,880	1,263,230
Lubricating oils " .	2,400,404	205,591	2,283,047	204,946
All other oils, " .	7,081,717	285,308	7,821,262	340,054
Paraffin wax, lb.	1,964,228	86,608	1,532,671	76,250
Fuel product	....	79,589	... .	70,815

The total value of refinery products in 1895 was $1,894,424, and the industry employed in the works an average of 355 workmen whose earnings were $190,007. In 1896 the value of products was $1,955,295, the average number of workmen employed was 351, and the earnings of labor were $190,-740. There are increases in yield and value of illuminating oils and all other oils, and decreases in lubricating oils and paraffin wax, but the net increase in values is $60,871.

It is interesting to study the improvement made in the extraction of oils from the crude, as shown by the percentage of products in the following table for a period of five years : Percentage of products from crude.

Product.	1892 p. c. of crude.	1893 p. c. of crude.	1894 p. c. of crude.	1895 p. c. of crude.	1896 p. c. of crude.
Illuminating oils....	38.67	39.12	41.10	43.310	45.084
Lubricating oils.....	12.35	12.45	10.91	9.510	9.075
All other oils.......	27.34	28.14	30.45	28.075	31.087
Totals..........	78.36	79.71	82.46	80.895	85.246

In those five years an increase of 6.886 per cent. has been made in the proportion of oils extracted from the crude, made up of a gain of 6.414 per

cent. in illuminating oils and 3.747 per cent. in all other oils exclusive of lubricating oils, and a loss of 3.275 per cent. in lubricating oils. As evidence of the use of successful treatment, these statistics are very gratifying.

EXPLORATION WORK IN KENT AND ESSEX.

Borings in Essex.

The good prices of crude oil led to a large increase in the number of wells in 1895 in the Petrolia and Oil Springs districts, and also to exploration for oil in other parts of the Province. Several wells were bored near the lake shore in the county of Essex, in one or two of which small shows of oil were found. On Pelee island also a number of wells were drilled and oil was struck in two of them. These are on the farm of John Finlay, one of them being 750 and the other 764 feet deep. In the month of January the latter was pumping two barrels per day of eight hours, and the former (which was finished on 13th November) $1\frac{1}{2}$ barrels; but it is stated that the pressure of gas, which is about 200 lb., hinders the rising of oil in the wells. Samples of the rock drillings from the deep well, examined by Dr. Coleman, are described as follows.

Record of rock drillings.

93—204 ft., bluish gray, effervesces a little with cold and more with hot acid, impure clayey limestone or dolomite.
450—500 ft., brownish gray dolomitic limestone, apparently a little bituminous.
660 ft., brownish gray dolomite, gypsiferous.
710 ft., pale brownish yellow, effervesces somewhat with cold acid, magnesian limestone ; also gray particles, a little gypsum
730 ft., pale brownish and white ; brownish is magnesian limestone without gypsum ; white is gypsum.
740 ft., (powder) pale brownish gray, dolomite and some gypsum.
749 ft., (powder) buff magnesian limestone or dolomite.
755 ft., grayish brown sand, dolomite, no gypsum.
759 ft., brown mg. limestone, bituminous, no gypsum, a calcite crystal.
761 ft., brown magnesian limestone, bituminous, no gypsum.
764 ft., pale gray dolomite, not bituminous, no gypsum.

Revival of prospecting in Bothwell.

In the early years of the '60s the region of Bothwell, in the county of Kent, was famous as an oil field, and scores of wells there were large producers; but in 1866 nearly all the wells were closed down and the field was abandoned for the more promising fields of Oil Springs and Petrolea. But the improved prices for crude induced a few operators to explore the Bothwell country again, and last year many farms were leased as oil lands and borings were commenced at a number of points. At the end of the year there were 35 producing wells, most of which were drilled in the last two months. A majority of these are on the north side of the river, in the township of Zone, and two or three in Mosa, but a considerable number are south of the river, in Orford. Borings have also been made in Aldborough on what was supposed to be a continuation of the oil-bearing belt, but no strike appears to have been made. The returns made by owners of wells show that the quantity of crude oil pumped was 305,580 gallons, valued at $12,734, while the railway returns give a total shipment of 62 carloads, computed at 297,600 gallons. Details of operations as gathered from the principal operators are presented below.

Producing wells in 1896.

Carman and Fairbank are one of the leading firms employed in operating the field. Frank J. Carman of New York state has been in the oil business for eight years in Pennsylvania, Ohio and Wyoming, chiefly as a refiner. He came to Bothwell early in 1896, and spent three or four months collecting data of the field and studying the prospects. Mr. Woodward of Petrolea had been engaged the previous year looking over the ground also, and the discovery of oil near the lake shore in Dunwich township suggested the idea that the course of the oil-bearing arch was nearly east and west. Mr. Woodward, with some Toronto associates, bored a well on lot 2 in the first and lot 1 in the second concession of Aldborough, near the river Thames, but got nothing. The record proved however that the wells were sunk upon low points of the arch, which suggested to Mr. Carman that drillings should be made further west along the line of the arch. Accordingly he commenced to bore on the Goodyear farm, lot 7 in the eighth concession of Zone. The drift had a thickness of 180 feet, composed of 20 feet sand containing water, 30 feet impervious blue clay, 30 feet gravel, sand and clay forming a hard pan, and 100 feet gravel, sand and hard pan. Below the drift the drill passed through 33 feet of what is believed to be Hamilton shale, and then for 187 feet through lime supposed to belong to the Corniferous formation A small flow of oil was found at 373 to 378 feet, and a strong flow of salt water at 399 feet in a loose granular limestone. The best producing band is five feet of the lower section of the 15 feet ending with 378 feet. Samples of the drillings from this well, furnished by Mr. Carman from the base of the shale, have been examined by Dr. Coleman who reports on them as follows : Carman and Fairbank.

Record of a well north of the Thames river, in Zone.

213-219 ft., bluish gray calcareous shale.
219-225 ft., bluish gray limestone, somewhat bituminous.
225-263 ft., pale gray to white limestone, with parts of brachiopods at 242-247 ft.
263-268 ft., bluish gray to white limestone.
268-278 ft., pale brownish gray to white limestone.
300-330 ft., grayish white limestone.
330-350 ft., grayish white limestone, with bluish gray fragments of shale, which may be accidental ; brachiopods at 340-345 ft.
350-360 ft., brownish white limestone.
368-373 ft., yellowish limestone.
373-383 ft., brownish yellow limestone.
383-388 ft., brown dolomite.
393-398 ft., brownish sandstone with calcareous cement.
398-399 ft., brown sandstone, well rounded grains.

These details may be summarized as follows :

213-219 ft., bluish gray calcareous shale.
219-225 ft., bluish gray limestone.
225-383 ft., pale bluish or brownish gray to white limestone.
383-388 ft., brown dolomite or dolomitic sandy limestone.
393-399 ft., brown sandstone.

The break in the series from 278 to 300 feet is reported by Mr. Carman as showing no change in the character of the rock ; while the break from 388 to 393 ft. is stated to be of a rock identical with the succeeding five feet. The pay-streaks in this well, he states, are at 373 to 378 feet and from 383 to 388 feet. Water was struck at 393 feet. A sample of drillings from another well from the same horizon as 383-388 feet is found to be a fragile brown dolomite, or dolomitic limestone. The thickness of the shale was

found to vary from 33 to 100 feet in the several wells bored by Messrs. Carman and Fairbank, the variations depending, it is believed, on the extent of erosion.

Evidences of a great pre-glacial river revealed by the borings.

In certain localities, as on lots 6, 7 and 8 in the seventh and eighth concessions of Zone, Mr. Carman discovered, from the records of borings, evidence of a pre-glacial river channel in the shale or soapstone. Across the lots named the general course of this river bed is east and west, with a north and south bend on lot 7 in the seventh concession, but the observations have not been careful enough to indicate the way in which the water had flowed. The channel is cut through the soft shale into the underlying hard limestone and has a breadth of about 250 yards, with a bed sloping from both banks towards the middle, where in places the river gravel has a thickness of 100 feet. Mr. Woodward has found evidence of a similar pre-glacial river near Sarnia, about half a mile east of the present outlet of lake Huron; and borings are said also to denote the existence of a large river bed below the drift near the shore of lake Erie at Port Stanley. But without fuller proofs by borings to show a continuous channel, it would be premature to say that at one period of their history long past, lake Huron was connected with lake Erie by a shorter cut than the St. Clair and Detroit rivers afford.

The science of prospecting for oil.

In the early days of the oil industry in Bothwell there was no science to direct the mind of the oil king or the well driller, and the practice commonly followed was to let a contract at a certain rate per foot under which borings were carried down until oil was struck, or were stopped for want of funds, or were abandoned in despair. Now, however, the aim is to ascertain the relation of the oil-bearing band of rock to sea-level, and to be guided thereby in sinking new wells—shutting down at the first appearance of salt water. There may be only one producing band, or there may be two or more; but whether one or more they are found to maintain as a rule a uniform relation to sea level. Account has to be taken however of erosion of the overlying drift by water, or of the upper rock formations by water or glaciers, and in practice the most reliable measurements are made from the surface of the uppermost rock that is free from erosion. In the Bothwell field the shale which underlies the drift is found to be of very unequal thickness, ranging as stated above from 33 to 100 feet, and therefore in delimiting the oil field by tracing the anticlinal arch measurements for sea level are made along the surface of the underlying limestone. Measurements made by Mr. Code of Glencoe show the levels of the limestone to be as follows, starting with the railway track at Bothwell station as 691 feet above sea level: On lot 21 in River Range, Zone, in the east end of the field three miles southeast from Bothwell, 420 feet. South of the last half a mile, on lot 26 in the fifteenth concession of Orford, 430 feet. On lot 26 in the fourteenth of Orford, 438 feet, being the highest point ascertained in that section. Westward from the last level through the middle of the river lots in Zone, the elevation runs from 440 feet on the McRoberts farm in the neighborhood of the old Pepper well (lot 19), to 445 feet on lot 17 and 450 feet near the graveyard on lot 13. On lot 7 in the eighth concession of Zone it rises to 465 feet and then

Relationship of the oil-bearing bands to sea level.

begins to dip rapidly to the west and the north. On lot 7 in the seventh it dips 22 feet towards the north· in 220 yards; and the greatest dip yet found is 63 feet in 440 yards from the middle of the same lot, towards the west. The western end of the field was not yet prospected at the end of the year; but from lot 7 in the seventh concession of Zone to as far east as the iron bridge on the Thames (the corners of Zone, Mosa, Aldborough and Orford), a length of four miles by a breadth of half a mile, its limits had been pretty carefully ascertained. In this territory about 60 wells were drilled last year, of which 40 have shown oil, and probably only half of these will be producers. Messrs. Carman and Fairbank put down ten wells, seven of which are producers, and all of them on one lot, 7 in the eighth concession of Zone. One of these began to be pumped in August, when it produced 100 barrels per day, but it dropped rapidly to 80 and slowly to 70, which was its rate of production at the close of the year.

The Walker Oil and Gas Company of Walkerville, organized with a capital of $250,000, was engaged steadily last year leasing lands in Zone and Orford, and prospecting for oil. Six drilling rigs were employed during the summer and fall and twelve wells were bored, four of which were producing oil at the end of the year. When no difficulties were met with, wells were completed in eleven days at a cost of about $250, but owing to boulders and quicksand in the drift the work of putting down the drive pipe was rendered very uncertain. Pipe lines were laid down to connect the producing wells with the railway, one of three-eighths of a mile from the Goodyear and Marcus farms, and one of over two miles from the Macdonald and Murphy farms—each of them 2½ to 3 feet under ground, or below the frost line. The company had secured leases on 1,864 acres of land, being 20 lots of 1,085 acres in Zone, six lots of 420 acres in Mosa, and six lots of 354 acres in Orford, the terms ranging from a seventh to an eighth of the product as a royalty to the owners. The Walker Oil and Gas Company.

Alexander Elliott of Bothwell was one of the first to begin operations after the revival of interest in that field, and he has in all six producing wells with a daily output of 50 barrels. They are all near the Longwoods road, on the Brewer, Lutze, Gesner and Sussex farms. Alexander Elliott.

W. H. Ramsay of Olean, N.Y., is manager in Bothwell of the American Oil Company, a copartnership of seven persons all residents of Olean. He came to Bothwell early in September, and succeeded in securing leases of 1,437 acres of land in Euphemia, Zone and Aldborough, embracing 26 lots and part lots, the royalty in each case being an eighth of the output of oil, work on six of the properties to begin within two months and on the rest within a year from the date of lease. One well was put down on lot 18 of River Range in Zone to a depth of 402 feet. A small show of oil was got at 245 feet and an improved show at 358 feet, at which the yield was four barrels per day. American Oil Company.

The Thomas E. Clarke Company, composed of Mr. Clarke of Bothwell and a London syndicate, have acquired 70 acres of the west half of lot 17 in the River Range of Zone, and have bored three wells thereon. The first Thomas E. Clarke Company.

reached 392 feet, and after being shot it yielded at the rate of fcur barrels per day. The second was drilled to 390 feet where brackish water was struck, but at 355 feet it gave a flow of oil estimated at two barrels per day. The third well, situated near the first but nearer the river, gave practically the same results, and water was struck at 385 feet.

Martin Woodward.

One of the most active drillers in the field is Mr. Martin Woodward of Petrolea, who has had a long experience in the oil business. He has bored a number of wells on both sides of the river and knows the ground thoroughly and has a careful record of levels. Speaking of the experiences of a generation ago he said: "Men did not understand the business very well, and often it happened that when fresh water and salt water became mixed and was changed to a black color it was supposed to be an indication of oil. We know now that it is a sign of a defective casing, and that the fresh surface water is mixing with the salt water from below." Referring to the closing down of operations thirty years ago he said: "When the Fenian raid took place in June, 1866, there was a rush of Americans across the border, and before quiet and confidence were restored the boom in Petrolea caused a break in price and crude oil fell from $10 to 50c. and even 25c. per barrel." A well on lot 20 in the sixteenth concession of Orford, bored by Mr. Woodward in November for Messrs. Whitman and Brinton of Findlay, Ohio, gave the following log:

110 ft. clay and hard pan.
102 ft. gravel and quicksand.
50 ft. soapstone; show of oil at bottom.
103 ft. limestone.
10 feet soft cutting porous limestone, showing oil.

The drill was stopped at 380 feet in limestone, and on 2nd December a pump was put in. After lifting water for an hour oil began to flow and in eight hours a 40-gallon tank was filled. The well is claimed to go 50 barrels per day.

Cost of sinking oil wells now compared with thirty years ago.

Mr. Woodward is a contractor and drills a well usually in two weeks' time. Some contractors work by the day of 12 hours at $10 to $12 for plant and three men, and others at a rate of $1.25 per foot; but where the work is carried on under direction of the owners or lessees of the land under skilled management, as by the Walker Oil and Gas Company, the cost of drilling a well under favorable circumstances is $250. Compared with modern methods and experiences, the following terms of a contract made thirty years ago is instructive and interesting:

Agreement made and entered into this fourth day of January, one thousand eight hundred and sixty-six, between John B. Harrison of the township of Zone, in the county of Kent, contractor, of the first part, and George Haight of the village of Bothwell, in the county of Kent, gentleman, of the second part.

The said party of the first part in consideration of the payments to be made as hereinafter mentioned agrees to sink or put down an oil well on the west half of the east half of lot number seven in the seventh concession of the township of Zone, county of Kent, at such site as shall be pointed out by the said party of the second part. The said well at the rock to be not less than seven inches in diameter in the inside, an to be lined with thin iron piping of not less than the above size. When the said rock is reached said piping to be well soldered together and to be put a sufficient depth in the rock so as to entirely shut off all surface drift, and otherwise to make a good and perfect hole.

To drill a hole in the rock to the depth of seven hundred feet from the surface (unless oil in paying quantities is found at a less depth), the same to be not less than five inches in diameter in the inside and to be made perfect in every particular.

The party of the first part is to furnish all tools, cables, wrenches, ropes, pulleys and other implements used or to be used in the sinking of the said well. To commence the sinking of the same as soon as the derrick is in a sufficiently advanced state to permit of his so doing and to prosecute the same with all diligence and vigor unto completion, either to the depth of the said seven hundred feet or until oil in paying quantities is found if the latter occur at a less depth, and when the same is complete in accordance with the above terms to deliver the same and all other machinery, fixtures and fittings used in the putting down of the same in good and perfect order.

It being understood by and between the parties hereto that the party of the second part shall furnish an engine and all machinery requisite to furnish power for the sinking of the said well in the rock and to put the said engines and machinery in good working order; to supply wood and water for the said engines during the process of the sinking of said well; also oil for lubricating the same and lights for said engine house; as also all tubing required for the said surface well or to shut off the soapstone in case the same is required, with solder to put the same together and to deliver the same at the said well a sufficient time before being required so as to occasion no delay in the sinking of said well.

In consideration of the sinking of said well in strict compliance with the above terms, the party of the second part agrees to pay to the party of the first part the price or sum of two dollars and seventy-five cents per foot for each and every foot the said well is sunk from the surface, without reference to surface or rock drilling, payments to be made as follows: The first payment to be made when the said well is sunk to the depth of fifty feet from the surface, and the subsequent payments to be made at such time and times as the said party of the first part shall have sunk or drilled to the depth of fifty feet between any two of such payments, and each of such payments to be in amount two-thirds of the contract price per foot for each foot the said well has been sunk between any two of the same; reserving the said one-third of the whole contract price per foot for each foot until the said well is sunk to the depth of seven hundred feet, or until oil in paying quantities is found if the latter shall sooner happen; and the said well and all other machinery, fixtures and fittings are delivered over to the party of the second part in good and perfect order and in accordance with the above terms, when the said balance shall be paid over to the party of the first part.

And it is further agreed by and between the parties hereto that in case any delay is occasioned in the sinking of said well by neglect or avoidable cause of the party of the first part, and the party of second part shall leave notice in writing of such neglect or delay where the said well is being sunk, and the said party of the first part shall not within four days thereafter proceed with and prosecute the sinking of said well in strict compliance with this contract, then and in such case it shall and may be lawful for the party of the second part to enter and take possession of the said well and to employ such person or persons as he may think proper to complete the same, and the money then due to the party of the first part shall be forfeited by him and shall be held as liquidated damages for such neglect or delay.

(Signed.) John B. Harrison.
Witness: D. McCraney. " George Haight.

These terms were so favorable, old timers of Bothwell now affirm, that in many cases the contractor cased off the oil when a good strike was made, in order that he might increase his earnings by sinking to the contract depth, regardless of the interests of "the party of the second part." And so it came to pass that the oil field became in time flooded with salt water, which had to be pumped out at heavy cost after each Sunday's rest, and at far greater cost if for any cause a well happened to be closed down a longer time. This was one of the causes which at last led to the abandonment of the field, according to the story of Mr. A. W. Newell of Bradford, Pennsylvania, who was manager of the largest well on the Thames thirty years ago. Mr. Newell came to Bothwell last December, led by reports of returning prosperity, and this is the story of the Pepper well as he gave it to the writer.

A cause of former failure of the field.

"I was a member of the Pepper Well Oil Company," Mr. Newell said, "organized at Boston to operate the Pepper well south of Bothwell, and I

The story of the Pepper well.

came here as manager in 1864. The sum paid for the property, which included thirty acres with one well down, was $20,000. At the time I took charge it was not producing oil in paying quantities. Pumping was continued about ten days, during which the oil came in spurts, but steadily increasing in flow. The output was kept up at 100 barrels per day until the company leased four portions of its lot, and when wells were put down upon them our supply fell off to 40 barrels per day. We operated the well until some time after the Fenian invasion of 1866, but that disturbance caused a large number of American owners to desert their wells and leave the country, and as the pumping ceased the salt water steadily rose and drowned out most of the wells in the locality. Ours then ceased suddenly to produce. There was nothing to indicate that the supply in the rock was exhausted, but simply it was shut off by the rising waters. I left the country some time in 1866, and soon after the company dissolved. I returned to Bradford, and with the experience I had gained in Bothwell was able to go into the business successfully there. The Pepper well was afterwards sold at sheriff's sale and I bought it for my wife, in whose name it now is. It was always allowed by the refiners that the quality of the Pepper well oil was superior to that of all other wells in the field, and it sold at 50 cents per barrel more. The usual selling price was $6 per barrel, but we sold as high as $7. I was third owner of the Lancey well at Petrolea, which was reported to yield 4,000 barrels per day, but I never got a dollar of it. The large production at Petrolea caused a drop in crude to 50 cents per barrel, and this along with the Fenian trouble led to the desertion of Bothwell. I never saw such a lively time as at Bothwell during the palmy days of the oil business, except at Petrolea."

Producing wells at the close of 1896.

Following is a list of the producing wells in the Bothwell field at the end of the year :

	No.
Carman and Fairbank of Bothwell	10
Alexander Elliott of Bothwell	6
Walker Oil and Gas Co. of Walkerville	6
Grand Rapids Oil Company	2
John Puddicombe, jr., of Bothwell	2
Wright and Davidson of Detroit	2
Whitman and Brenton of Findlay, Ohio	2
Emerson Company of Chatham	1
Gurd and Kippin of Petrolea	1
American Oil Company of Olean, N.Y.	1
J. R. Menhinnick of London	1
E. C. Lefevre of Bothwell	1

NATURAL GAS.

The statistics of natural gas in Ontario are given in the following table for the four years 1893-96 :

Statistics for the four years 1893-96.

Schedule.	1893.	1894.	1895.	1896.
No. of producing wells	107	110	123	141
Value of gas product $	238,200	204,179	282,986	276,710
Miles of gas pipe	117	183½	248	287¼
Workmen employed	59	99	92	87
Wages for labor $	24,592	53,130	73,328	47,527

There were 26 wells drilled during the year, 18 of which yielded gas, but of the total of 141 which are gas-bearing 8 are sealed up awaiting a market. In the Welland field as in former years the bulk of the gas is piped into Buffalo, and in the Essex field a large proportion of it was last year supplied to Detroit, in addition to the quantities consumed at Windsor and Walkerville.

The example of Leamington, in Essex county.

The town of Leamington, in Essex county, offers a good illustration of what may be done by utilizing the bounties of Nature for the public service. In 1892 the Ontario Natural Gas Co. bored a well in Gosfield township, 3½ miles west of Leamington, and a flow of gas was struck at 970 feet. This proved to be one of the best wells in the district, the pressure of gas in it being 450 lb. per square inch. A pipe was laid to connect it with the town, and a supply service was put in under arrangements made with the municipal council as to rates for fuel and light. For cooking stoves the rate was $1.65 per month, for heating stoves $1 90, and for furnaces $2.75; only one or two parties took gas by measure, and for these the rate was 12½ cents per 1,000 cubic feet. This service was continued until the fall of 1895, when a syndicate of citizens undertook to drill a well within the corporation limits on the understanding that the town would take it over if gas was found. The site selected was at the foot of Erie street, on the lake shore, and a flow of gas was struck at 987 feet with a rock pressure of 440 lb. per square inch. The town thereupon became the owner of the well at cost price, which was a little under $2,000, and the service plant was purchased from the Ontario Natural Gas Co. at a valuation of $14,000. A second well was bored last year at a distance of 100 yards from the first, and gas was struck at 997 feet. The two have a capacity as tested of 11 500,000 cubic feet per day, and it is estimated that the consumption does not exceed 150,000 cubic feet per day. The supply is drawn from the wells alternately, and in case an accident occurs to one of them, or its regulator requires to be cleaned out, the other is ready for use. Delivery pipes are laid on nearly every street, and about $6,000 was expended on extensions during 1895 and 1896. The total number of takers in the first of these years was 389, and in the second 443, including a number of factories. The rates are slightly lower than those paid to the company, being $1.50 per month for cooking stoves, $1.75 for heaters and $2.50 for furnaces; but in the case of heaters and furnaces the charge is only for seven months of the year, any gas consumed over that time being free. The factories and mills are metred, and the daily cost to the larger establishments runs from 25 to 50 cents per day, the rate being five cents per 1,000 cubic feet. When gas is consumed for light the charge is 16 cents per month for one burner, 15 cents each for two, and 14 cents for three or more, being the same as the rates charged by the company. For the care of the wells and plant only two men are employed, one of whom attends to the regulators and is paid $50 per month, while the other is paid $1.50 per day for attendance on the wells and putting in services. A system of waterworks was established in 1891, when a well was bored on the north side of the town to a depth of 47 feet in the drift. The drill went through 42 feet of clay and five feet of hard-pan, when it dropped two or three feet into a bed of fine gravel like the lake shore sand. A 7-inch pipe was put in, and the water has been ascertained to rise 12

Water supply.

feet above the ground level; the capacity is over 30,000 gallons per hour. A second well was bored last year within 100 yards of the first, where an equally good flow was obtained at the same depth. Tests show, it is claimed, that the water of both wells is absolutely pure. Waterworks have been erected, 15 miles of service pipes have been laid down, and water is supplied to householders at $5 per annum. Factories are supplied free, and besides gas for fuel at the nominal rate of five cents per 1,000 cubic feet, they are exempted from taxation as far as the statute allows for a period of ten years. The town has a thrifty appearance, a number of manufacturing establishments have been erected recently, many of the dwellings are new, and during the past year $10\frac{1}{2}$ miles of sidewalks of gravel and Portland cement were laid down at a cost of $19,000, charged on the frontage plan. The revenue from water and gas is shown in the following table for the last three years, compiled from a statement furnished by the town treasurer:

Revenue from water and gas.

Schedule.	1894.	1895.	1896.
Water—			
No. of takers	73	114	171
Receipts ..... $	210.36	667.95	786.49
Gas—			
No. of takers	....	389	443
Receipts ..... $	....	2,317.33	8,344.23

The gas works were opened on 1st October, 1894, and since that time the receipts from them have been an important source of the town's revenue. The total for water and gas last year was $9,130.72, and has sufficed to cut down the rate of taxation for municipal and school purposes to less than one-half the rate of 1894. In that year it was 25.3 mills on the dollar, in 1895 it was 23.9, and last year it was only 12.4 With such a demonstration of the service of one of Nature's bounties at home, it is not at all likely that the citizens of Leamington will favor the laying down of pipe lines from their wells to deliver cheap fuel across Detroit river.

CARBIDE OF CALCIUM.

The reception of new inventions in a scientific age.

In the history of new inventions or discoveries, it is frequently found that high expectations held at first on apparently tenable grounds have been slow of realization. Difficulties of construction or of treatment prove obstinate, new problems presented by the application of new methods demand time and patience for their solution, and unsuspected obstacles block the pathway to complete success and recognition. If the machine or process have general merit, however, and the result to be attained from a general introduction into that part of the realm of arts to which it pertains hold out sufficient hope of reward, human skill, ingenuity and perseverance may be relied upon to bring it to the necessary degree of perfection. And in this age of widespread diffusion of scientific and mechanical knowledge, and of innumerable trade and technical newspapers and journals, every new discovery in

science or the arts is seized upon, tested and developed by a host of tireless workers in many nations. The discovery of a new element sets a thousand chemists and physicists at work to isolate it, examine its properties and determine its affinities; the announcement that wood and human flesh and other substances long believed to be opaque have been found to be really pervious to certain kinds of rays, enlists a host of eager experimenters in the effort to ascertain the nature of the new agent and to explore the fresh field of research which has thus been opened; and the publication of the fact that a method has been found of producing in commercial quantities the raw material for the synthesis of a whole series of useful compounds, and the generation of an illuminant of great brilliancy, is the signal for a simultaneous attack upon the properties of the substance and the best methods of utilizing it by scientific men and trained observers the world over. The multiplicity of investigators leads to a speedy elucidation of the problems involved; and this is the return which the world is reaping from the scientific education now everywhere so freely provided.

Willson's method of producing carbide of calcium

The discovery by Mr. T. L. Willson of a method of producing carbide of calcium by the fusion of coke and lime in an electric furnace, which was made by him in 1892 and patented in 1894, has been dealt with in previous Reports of the Bureau, particularly in that for 1894. The significance of the discovery lay in the fact that by simple contact with water calcium carbide gives off acetylene gas, at once a powerful illuminant and the starting point of a wide range of possibilities in organic synthesis. The material is scarcely acted upon by other agents, but readily decomposes and is decomposed by water, losing its lime and taking up the hydrogen of the water, the resulting compound being made up of two parts of carbon and two of hydrogen, expressed thus, C_2H_2. The building up of other substances from acetylene gas, such as benzine, nitro-benzine, aniline, carbolic acid, picric acid, ethylene, ethane, alcohol, and even sugar, is as yet a matter for laboratory experiments rather than for commercial practice, and it is in the role of an illuminant that the gas is of present and pressing importance. When collected in a suitable holder and delivered to proper burners, acetylene is one of the most brilliant illuminating agents yet discovered. The light has not the glare of the arc lamp, or the reddish glow of the incandescent loop, and the flame in color and temperature is specially grateful to the eye. Tests have shown that it possesses about twelve times the illuminating power of good coal gas, while producing, for equal quantities consumed, decidedly less heat. It can be liquefied, too, by pressure or cold, and thus rendered highly portable and available for use in lighting railway cars, etc. Given, then, a substance automatically producing so high a quality of gas by mere contact with water, the expectation was not unnaturally entertained that the new illuminant would at once enter upon a career of unlimited usefulness.

HINDRANCES TO SPEEDY ADOPTION.

So far however the adoption of the light has been by no means so general as was at first anticipated. Several reasons have contributed to this. Those arising from difficulties connected with the generation and use of the

Some difficulties, and means to overcome them.

gas are thus stated by a writer in a recent periodical: "Corrosion in the metal fittings and connections, with the formation of metallic acetylides, became apparent. The generator often became highly heated, and the temperature did not always diminish upon the stoppage of the water, nor did the formation of gas cease. The burners became choked, and the illuminating power of the gas varied, and altogether the results of experience showed that much was yet to be learned about the generation and use of acetylene. Added to this came the fear of explosions; particularly with the liquefied gas several dangerous and some fatal accidents occurred, rendering it evident that the new illuminant needed thorough investigation "[1]

Extensive experiments made by French and other scientists, notably by M. Pictet, have however thrown so much light upon the difficulties encountered in the use of the gas and the means to be taken in order to overcome them, that it seems no longer doubtful that acetylene will take its place as a "safe, successful and economical illuminant." Pictet's investigations showed that the generation of acetylene by adding water to calcium carbide in closed vessels from which the gas cannot escape may, by liberation of latent heat and accumulation of gas, bring about temperatures and pressures sufficiently high to cause disastrous explosions. By providing capacity for holding the maximum production of gas, or by the use of suitable safety-valve or relief chambers, undue pressure may be guarded against. Rise of temperature to a dangerous point, too, may be prevented by employing coils of pipe containing cold circulating brine which carries off the surplus heat, or, more easily still, by immersing the carbide in a quantity of water large enough to absorb the heat as it is given off, the supply of water being renewed at suitable intervals. The practice of generating the gas by bringing large masses of calcium carbide into contact with small quantities of water is one undoubtedly attended with risk, owing to the heat evolved during the operation. Impurities found in acetylene are ammonia, sulphuretted and phosphoretted hydrogen and carbonic oxides, of which the first named is very objectionable, owing to the fact that it greatly promotes the formation of fulminating acetylides of copper when the gas containing it comes in contact with that metal or an alloy of it. These compounds are very explosive under the influence of shocks or slight elevations of temperature. When acetylene is generated in an excess of water nearly all of the ammonia and much of the sulphuretted hydrogen are taken up, and the gas is consequently much purer and safer than when produced in any other way. It may be still further purified and the entrained moisture removed by dessicating materials, after which the gas will no longer attack copper, or foul the tubes or burners, and will give uniformly its maximum illuminating effect. "Against such acetylene," says the writer already quoted, "there is no reasonable objection on the score of danger. It is probably no more poisonous than ordinary illuminating gas, while its characteristic odor causes leaks to be readily detected. A number of experiments by Vieille and Berthelot have demonstrated that at atmospheric pressures a decomposition originated at any point

[1] History, Status and Possibilities of Acetylene, by Henry Harrison Suplee, in The Engineering Magazine for August, 1897, p. 790.

is not propagated through the mass of the gas. Neither a spark, an explosion of fulminate, or direct contact with flame causes any action beyond the immediate vicinity of the heat. When however the gas is subjected to a pressure greater than two atmospheres, it exhibits all the properties of an explosive mixture; hence the danger line is clearly and definitely marked. Mixtures of acetylene are, or are not, explosive according to the proportions of the two components, the limits being between three of gas to one of air, up to twenty of gas to one of air, this being a somewhat wider range than is found with ordinary illuminating gas; with the care now taken against approaching leaks with lights, there is no greater danger."[2]

Properties of acetylene in the liquefied form.

Acetylene can be readily liquefied by pressure and cold, being reduced to the liquid form at the freezing-point by a pressure of twenty-one and a half atmospheres. At 62° Fah. liquid acetylene occupies only one four-hundredth the volume of the gas, hence attempts were quickly made to utilize it in this form for such purposes as the lighting of railway carriages, the only apparatus required being a reducing valve to maintain a uniform pressure of two to four inches of water on the main leading to the burners. Several explosions resulting in loss of life at Berlin, Paris and New Haven took place however when cylinders containing the liquid acetylene were brought into play for this object. Further investigation into the cause of these explosions showed that not sufficient room had been allowed for the expansion of the liquefied gas under the influence of an increase in temperature; in other words, that the cylinders were too full. Liquid acetylene is an extraordinarily expansible fluid. One volume of it at 32° Fah. becomes 1.07 volumes at 62°, and 1.24 volumes at 96°, thus expanding nearly one-fourth of its original volume at the temperature of a midsummer day. Full provision for this property of expansion is made when the cylinders are not filled to more than one-half their capacity, and cylinders so filled have been subjected by M. Pictet to the temperature of boiling water without any untoward result. If this precaution be neglected, and the cylinder containing the liquid acetylene be exposed to a degree of heat sufficiently great, the enormous force put forth by the expanding liquid will not only rupture the vessel but will set free the liquid itself at a pressure almost equal to that exerted by exploding gun cotton. Acetylene in the form of a liquid and acetylene in the form of a gas are two different things however, and the dangers connected with the liquid should not be confounded with any supposed dangers connected with the gas at ordinary temperatures. It has been proposed by MM. Claude and Hess of Paris to store acetylene in small bulk by dissolving the gas in acetone, a liquid which possesses the property of absorbing at atmospheric pressure thirty-one times its own bulk of the gas. The acetylene is dissolved under pressure, and is given off again on the pressure being relieved. This method is devoid of danger when the pressure under which the gas is dissolved does not exceed ten atmospheres; but beyond this point the solution begins to partake of the nature and properties of liquid acetylene, and must be handled in the same way. Among the numerous fields for the employment of liquefied acetylene Prof. Vivian B. Lewes, a recognized English authority on the subject of gas, has pointed out that one afforded by

New spheres of utility for acetylene.

[2] H. H. Suplee, in The Engineering Magazine for August 1897, pp. 792-3.

ships, buoys, lighthouses and naval appliances generally. He says: "When it was considered that a cylinder holding one cubic foot of the liquefied gas would supply a burner giving a light of 32 candles for 400 hours, it was evident that there were great possibilities for it in the future on ships and yachts not fitted with the electric light. With a proper and special arrangement, highly efficient gas engines could be driven by it, and in small atmospheric burners it gave a flame of very high temperature; so that it was by no means impossible that the twentieth century might see a high speed torpedo boat driven by an acetylene engine, with an acetylene search light and an acetylene cooking stove, while some might even add to the equipment an acetylene torpedo, as a most effective 'Sprengel' explosive might be made from liquid acetylene and chlorate of potash. These were dreams of the future, but there were certain spheres of utility ready for acetylene in which no plea of danger could be urged against its adoption. The first of these were floating buoys. At the present time there were four methods by which these could be lighted: (1) electricity, (2) compressed oil gas, (3) compressed coal gas enriched by gasoline, (4) Wigham's oil lamps. With electricity, the chance of conducting wires being fouled by an anchor or dredge always existed; the compressed oil gas needed a small gas works and compressing plant; compressed coal gas and gasoline enrichment demanded the latter, if not the former; while Mr. Wigham's oil lamps stood out as being both good and economical. There was room however for acetylene for this purpose, and a cylinder of liquid acetylene having a capacity of 1.75 cubic feet, fitted with a reducing valve, and stored in the bottom of the buoy, would give a clear white light of 32 candles for one month, and in cost would even now be about equal to compressed oil gas giving the same amount of light. If legal restrictions should prevent liquid acetylene becoming a commercial commodity, then compressed acetylene gas in cylinders, of the Pintsch or Pope pattern, could be effectively used, the gas giving a candle power three times as high as the best freshly pumped oil gas. For such purposes as buoy lighting and for use in lightships, the cylinders of liquefied acetylene seem to be especially adapted, while the still more important function of an auxiliary light for use in lighthouses would be best carried out with the uncompressed gas. For lighthouse use the apparatus would be so rapid in action that, even with the holder empty, gas could be made and the lantern burning within a very few minutes of the breakdown of the electric apparatus."[3] In the important point of penetrative power, Prof. Lewes found by experiment that the light given by acetylene ranked higher than that of the electric arc or incandescent gas, but slightly below oil and coal gas, the percentage of light absorbed in a fog-solution employed being as follows:

For lights at sea.

Coal gas	11.1
Oil gas	11.5
Acetylene	14.7
Incandescent gas (Welsbach)	20.8
Electric arc	26.2

A minor but important use to which calcium carbide might be put is the

[3] Address on "Acetylene Gas and its Probable Future Afloat" before the Institution of Naval Architects, 8th April, 1897, Scientific American, 14 August, 1897.

manufacture of signal lights for use at sea. This depends upon the presence in the calcium carbide of a certain proportion of calcic phosphide, occurring as an impurity in some specimens of the material made on the continent of Europe. On contact with water, the calcic phosphide gives off sufficient spontaneously inflammable phosphuretted hydrogen to ignite the acetylene evolved at the same time. If cartridges such as those used for the Holmes lights were filled with a mixture of calcium carbide and calcium phosphide, they would on being placed in water give off a mixture of acetylene and phosphuretted hydrogen which would at once ignite on coming into contact with the air, and could with great advantage be employed to indicate the position in the water of life belts, torpedoes, etc. Such a candle, if attached to the life buoys flung overboard at night, would not only guide a swimmer to the buoy, but also mark the direction in which the ship's boats had afterward to proceed.

Constant experimenting with acetylene is still being carried on, especially in England and continental Europe, where very great interest has been aroused in the subject, to determine the properties and behavior of calcium carbide and acetylene under all circumstances, and also to perfect the most suitable and economic generating apparatus, many types of which have already been invented. Experimentation.

THE COMMERCIAL OUTLOOK.

The question has also its commercial side—an all-important one in this age when fine theories and glowing promises are brought to the test of debit and credit. If acetylene cannot give as good, as safe and as cheap a light as coal or water gas at the same price, its chances of coming into general use are, to say the least, problematical. The raw materials of calcium carbide are of the commonest and cheapest kind, being nothing more costly than powdered coke and lime, but the degree of heat required for their fusion is very great, and can only be attained in the arc of the electric furnace. Heat is but a form of force, and the amount of power required to operate an electric furnace and produce a temperature sufficiently high to effect the chemical combination of carbon and lime is correspondingly great. Electricity can be generated by the combustion of coal through the intervention of the steam engine, but this method of obtaining power cannot compare in economy of cost with that afforded by the falling of water, especially in large bodies and from considerable heights. Cheap power, which is an essential in the production of calcium carbide, can in fact be obtained only from waterfalls; hence all the plants which have been put up for its manufacture are situated where such power is available. In America the existing manufactories are at Niagara Falls, N.Y., Lockport, N.Y., and Merritton, Ontario, and in Europe at Neuhausen on the Rhine, at Froges, and at the Falls of Foyers in Scotland, at all of which places the energy contained in falling water is used in the generation of the necessary current of electricity. The minimum theoretical amount of power required to produce the heat for the production of one pound of calcium carbide per hour is 2.02 horsepower. A water privilege of 2,000 horsepower would therefore, presuming no energy whatever was lost or wasted, be capable of yielding rather less than twelve tons of the carbide per twenty-four hours. In practice of course the output would The commercial side of acetylene.

be much smaller, probably one-half to three-fourths of the maximum. It can be readily seen, then, how important an item is power in the manufacture of calcium carbide.

Willson's works at Merritton.

At the factory which Mr. T. L Willson—whose discovery of the electric method of producing the carbide has practically called the whole business into being—has erected on the old Welland canal at Merritton, the material was in 1896 being made and sold for $80 per ton of 2,000 lb. At this price it is stated to be equal for illuminating purposes to ordinary gas at 57 cents per thousand feet. Whether, all things considered, this is sufficiently low in price to tempt people away from the use of a gas with which they are familiar and induce them to adopt a gas with whose behavior they must make themselves acquainted, and whose character for safety has been decried in advance, may perhaps be considered doubtful. But there can be little doubt that if the cost of manufacture be not too great to admit of genuine competition with gas and electric light, these and other illuminants will ere long have a formidable rival in acetylene. Mr. Willson is now utilizing the power of two locks on the old Welland canal, connections with the second lock having been made on 15th March, 1897. The locks yield about 400 electrical horsepower each, or 800 horsepower altogether. This is sufficient to operate four furnaces twenty-four hours a day, and to produce about three tons of carbide daily, for which a ready market exists in Canada and Europe. An account of the works was given in the Report of the Bureau for 1895, pp. 37-41. Mr. Willson has expended about $120,000 upon the factory at Merritton, but in his opinion this comparatively small plant is very far from exhausting the possibilities which the manufacture of calcium carbide presents. He has in view the erection of works upon a very large scale at some point in Canada, plans for which are now under consideration.

SALT AND GYPSUM.

Of the fourteen salt works which were in operation in 1895, two were idle last year. The following statistics are given for the five years 1892-6 :

Comparative statistics for the five years 1892-6.

Schedule.	1892.	1893.	1894.	1895.	1896.
Tons made	43,387	48,350	35,215	51,009	44,816
Value ....$	162,700	149,850	115,551	188,101	204,910
Wages .... $	37,800	44,440	43,350	56,496	50,650

The product in 1896 is less in quantity than in the previous year, but the value is larger. The average number of men employed in the industry was 173, and the average wage earnings for the year was $292. The plant for the manufacture of soda ash in course of construction at the Ontario People's salt works in Kincardine, to which reference was made in last year's report, was not fully completed at the end of the year.

The largest salt works in the Province are located at Windsor, the pro-

Canoeing in Shallow Waters, Upper Seine River region (Partridge Creek).

Canoeing in Shallow Waters. Another view.

Falls on Upper Seine River.

Island Falls on Seine River.

perty of the Windsor Salt Company (Limited), and during last year their capacity was increased by the boring of another well, which has demonstrated the existence there of a very large body of salt. The following log of the boring gives the thickness of the several formations :

The Windsor wells and works

	ft.		ft.		ft.
Drift	0	to	133	—	133
Limestone	133	to	1055	—	922
Salt	1055	to	1085	—	30
Limestone	1085	to	1110	—	25
Salt	1110	to	1185	—	75
Limestone	1185	to	1285	—	100
Salt	1320	to	1390	—	70
Limestone	1390	to	1420	—	30
Salt	1420	to	1672	—	252
Limestone	1672	to	0		

Possibly there may be salt at a lower depth, but borings made elsewhere in the salt area of the Province do not point to the likelihood of it. It is true that Attrill's well at Goderich, which was bored with a diamond drill to a depth of 1517 feet, proved the existence of six beds between 996 and 1385 feet, but the thickness of the fifth was only 13 and of the sixth 6 feet.

The well sunk by Hiram Walker in the township of Orford reached a total depth of 2200 feet, and only one bed of salt was penetrated. This was struck at 1510 feet and showed a thickness of 171 feet of clear white salt. The aggregate thickness of the four beds at Windsor is 392 feet, with intervening strata of limestone and shale measuring 225 feet. The lowest one, found at 1420 feet, would appear to lie in the same horizon as the Orford bed, but its thickness is greater by 81 feet. A square mile of the Windsor field is estimated to contain in the four beds 750,000,000 tons of salt, or more than could be exhausted in 1600 years at the average production of the last five years ; and as the salt beds underlying the counties of Huron, Bruce, Middlesex, Lambton, Kent and Essex have an area of about 1200 square miles, it will readily be perceived that the supply is illimitable.

An illimitable supply in the western counties.

The gypsum mines were worked irregularly, but the total output in the year was about 3,500 tons, valued at $10,500. There was used in the manufacture of calcined plaster, alabastine, etc., 700 tons, valued at $10,250.

Gypsum production.

MICA AND APATITE.

The mica and apatite mines are for the most part lying idle, and the reports of them are very unsatisfactory. A little over 2,000 tons of mica is reported as having been mined, but no value is placed upon it. It does not appear from the returns received that more than 5,000 lb. of cut mica was produced during the year, the value of which was $2,425, while the product of the apatite mines was a blank.

A state of inactivity at the mines

The Standard Fertilizer and Chemical Company's works at Smith's Falls produced during the year 300 tons of superphosphate from apatite, valued at $6000, employing four men whose wage earnings were $1440. A considerable additional quantity of superphosphate is manufactured from bones, and the manager of the Company asserts that this is a result of the operation of the present Fertilizer Act. "It works in this way," the manager writes : "Insol-

Production of superphosphate

uble phosphoric acid in ground bone is valued at six cents per pound by the Department in control of the Act, and at two cents per pound in the ground apatite. Now it is a fact in manufacturing superphosphate from apatite that a considerable excess in acid has to be mixed with it in order to dissolve the whole of it, on account of its density and hardness. The way then is to mix this excess of acid, and when it has dissolved the whole mix it with enough bone meal to dry so that it can be worked. Only a small part of the bone meal will become soluble, and the Department on account of part of the superphosphate having been made from apatite assumes that the whole of the insoluble phosphoric acid is in the form of apatite and values it at two cents per pound instead of six cents, as it should be. This amounts to from $2.50 to $3 per ton in the valuation, so that we are handicapped that amount in using apatite."

Manufacture of scrap mica for pipe coverings.

The manufacture of scrap mica into coverings for locomotive and marine boilers, steam pipes, etc., which was commenced last year in Toronto by the Mica Boiler Covering Co., Limited, progresses steadily, the output of the factory having doubled. The management state that they anticipate an equally large increase of business next year as the properties of the material become more widely known. The extensive use to which the scrap mica can be put, not only as an insulator of steam heat but also as a protection to cold water pipes from frost, and the satisfactory results obtained by those who are already using it, seem to promise the building up of a new and important industry in Canada. The company obtains its raw material almost entirely from Ontario mines, although small quantities of other mica have been tried. The number of employés varies with the season from 20 to 30, but as the business is steadily growing more hands must continue to be taken on, and it is likely that larger premises will soon be required. To the owners of mica mines this industry means much, as they can now sell at a fair price a large portion of the mineral raised which heretofore was thrown on the waste dump.

GRAPHITE.

The graphite industry in Ontario and elsewhere.

The discovery of a large vein of graphite in a formation of crystalline limestone on the south side of Whitefish lake in Brougham township, Renfrew county, and the erection of works to treat the ore in the city of Ottawa, awakens interest in an industry which a quarter of a century ago was carried on with some promise of success at Oliver's Ferry, on the Rideau canal waters. The manufacture of graphite is not a business to be lightly undertaken, for there are processes known only to experts whose services are not easily or cheaply procured. In the United States there are one or two large establishments where native and imported ores (chiefly the graphite from Ceylon) are treated to produce material for crucibles, stove polish, pencil stock, lubricants, etc., but the chief seat of the graphite industry is in Germany, where at least two establishments employ as many as 1,000 workmen each. Where there are large supplies of the ore, and where capital and skill may be encouraged to utilize them, as there is reason to hope is the case in Ontario at the present time, some knowledge of the processes which have been adopted elsewhere and some account of what has been undertaken at home may be found useful and instructive.

THE WORKS AT OLIVER'S FERRY.

As for the history of the graphite industry in Ontario, I believe it is limited to one enterprise—the works at Oliver's Ferry, in Lanark county. The process by which the ore obtained there was treated has been described to me by Mr. John Robb, of 571 Somerset street, Ottawa, who constructed the mill and had charge of the works for several years. One method of treating graphite ore is well described in the following narrative:

Story of the graphite works at Oliver's Ferry in Lanark county.

Mr. Robb, who is a machinist by trade, worked at Acton copper mines in Quebec as mechanical superintendent and afterwards for two years in the same capacity at the Capelton mine, under Thomas Macfarlane, who was manager of both works. About 1872 he went to Oliver's Ferry to put up machinery for a graphite mill, and was there three years as superintendent of it, when he left to build a mill at Buckingham in Quebec. The Oliver's Ferry mill was a two-storey building of 60 by 160 feet. It was equipped with two batteries of five stamps each for reducing the ore to pulp, made by Gilbert & Co., of Montreal, and driven by a 25 h. p. engine built at Hamilton. The stamps had a weight of 75 lb. each, and their drop ranged from 8 to 15 inches. The ore was broken to egg size and was fed by hand into the batteries, which were supplied with water delivered through a pipe. The pulp passed out of the batteries by an overflow "flosh," and was carried into a circular buddle of 16 feet diameter and 26 to 30 inches depth, there to be stirred by a revolving sweep. The earthy parts, being of greater specific gravity, would settle towards the centre and the graphite towards the circumference, while the water escaped through openings at successive levels in the rim. By this process the bulk of the valuable mineral in the pulp was separated from the rock, and when the buddle was filled to a depth of about 16 inches the charge was allowed to settle for five or six hours. The concentrate was shovelled out upon the floor, and the tail or earthy matter was returned to the batteries for a second operation, to recover any graphite which might be contained in it. The richer portion or concentrate was put into a second buddle somewhat smaller than the first, where it underwent the same operation, and thence it passed through a third buddle of about 10 feet diameter. Very little rock matter was left when the third operation was completed; but still another process was required to finish the separation as far as this could be done by concentration process. The selected portion of the charge was thrown into a settler 4 feet high, 4 feet diameter at the top and $2\frac{1}{2}$ feet at the bottom, to which water was added. Two men with iron bars tapped the outside of the vessel steadily to keep up an agitation, and gradually the heavier earthy particles settled at the bottom. When the settler was full it was allowed to stand $1\frac{1}{2}$ to 3 hours, when the cleanest graphite was carefully taken off and was spread upon the top of a reverberatory furnace to dry, being frequently stirred to prevent caking. The refuse at the bottom of the settler, which contained a good percentage of graphite, was returned to the stamps to go through the same treatment again. After the graphite was dried it was put into the furnace to drive off particles of antimony, arsenic, and other foreign substances, and when sparks ceased to rise the process of purifying was regarded as finished. The charge was then drawn from the furnace and

Mr. Robb's narrative.

Graphite.

spread upon a stone floor, after which it was elevated to bins on the second floor. From these bins it was delivered through a funnel to be passed through a set of four revolving seives for grading. The first was of 60-mesh fineness and recovered the coarse flakes, which were the best quality of graphite; the second, third and fourth seives were of a regularly increasing fineness of mesh, and the quality of the graphite separated by them was graded accordingly. The coarse flakes of the first quality were fed into rumblers or cylinders of iron riveted together, 5 feet long and $2\frac{1}{2}$ feet diameter, loaded with 300 iron balls of $1\frac{1}{2}$ to $\frac{3}{4}$-inch diameter. There were three of these placed side by side, and being provided with cog-wheel gearing the first drove the other two. Each was charged with 200 to 300 lb. of flake graphite, and the opening through which the charge was fed was securely closed by an iron plate. The rumblers were driven for 6 to 10 hours, when the door plates were taken off and others with fine perforations substituted for them. Or, to get the finest quality, these latter plates were covered with screens of brass through which only the smallest particles could escape. The room in which the cylinders were placed was 12 feet square at the floor, 8 feet square at the ceiling and 10 feet high, and was fitted with shelves at intervals around the walls. When the machines started to revolve again, the force of the centrifugal motion produced a discharge, and in the course of two or three hours they were emptied. The finest quality was collected from the shelves, and the coarsest from the floor, and these were packed into bags for shipment. The best quality of flake graphite was used for electrotyping; a second quality, of which there were two or three grades, for lubricating purposes; a third quality for pencil stock; a fourth quality, of which there were different grades, for stove polish; and a fifth quality for foundry facings. The poorer qualities separated by the seives were used for cheaper grades of stove polish, foundry facings and other purposes. The chief source of the ore supply was a mine on the farm of James King, which the company worked. The mineral did not occur as a vein, but was disseminated through the country rock, constituting 10 to 20 per cent. of it. A pit 300 or 400 feet long, and perhaps 200 feet wide, had been opened to a depth of 20 feet when Mr. Robb left Oliver's Ferry. Graphite was also purchased from several parties on the other side of Rideau lake, but it was of poor quality, being full of iron pyrites and other impurities. The works were closed down soon after his leaving the company's service.

THE GRAPHITE INDUSTRY IN FOREIGN COUNTRIES.

Manufacture of graphite in United States and Germany.

It is estimated that fully one-third of all the manufactures of graphite consists of crucibles and refractory articles, and one-third of stove polish, while lubricants and foundry facings make up a quarter, and pencil stock not more than three per cent. of the whole. The Ceylon graphite is regarded as the best in the world, being largely composed of flake, and it is therefore in demand by manufacturers in Germany and the United States for mixture with the poorer qualities procured from their own mines. The largest known deposit is believed to be in Schwerzbach, which has a length in a straight line of about 3,000 feet, with a maximum width between walls of 45 feet, and it has been worked to a depth of over 200 feet. There are a number of works

in Germany for refining the ore, each of which has its special process, and there are many more works where the refined graphite is used as the raw material of the manufacturer. At the pencil factory of A. W. Faber at Stein, in Bavaria, as an example, 900 people are employed, while at the factory of Johann Faber at Nuremberg, also in Bavaria, more than 1,000 people are employed. In refining the ore some works use a process known to the trade as dry cleaning, others use the washing process, others a chemical process, and others again a combination of these. The process described by Mr. Robb consisted largely in washing the pulped ore, but in one part of the course the furnace treatment was employed. It seems likely that each ore requires a process suited to itself, which must be the case where the earthy or rock materials of the ore differ from each other, or where the gangue is a mixture of a variety of minerals.

THE ONTARIO GRAPHITE COMPANY'S WORKS.

Mine at Whitefish lake and refining works at Ottawa.

The mine at Whitefish lake in Brougham is known as the Black Donald. The vein outcrops near the lake, where it has a width of 25 feet. Its course is nearly northeast and southwest, between walls of crystalline limestone, and it dips about 70° east. Along the foot wall for some distance the graphite is banded with limestone, and while analyses show a small percentage of lime in all the ore, more than three fourths of the width of the vein is apparently free from it. Pits and cross-cuttings have exposed the ore body for a length of about 300 feet. Towards the north it passes under the waters of the lake, and southward it is covered with sand; but although the extent of the vein has not yet been defined, there is no doubt whatever that a large amount of ore is in sight. During last year 15 men were employed at the mine for four months, who took out 650 tons of ore. It has to be drawn a distance of 12 miles to Calabogie station on the Kingston and Pembroke Railway, and thence it is shipped to the refining works at Ottawa. These works are on the Ottawa river, and have been constructed under the directions of Mr. F. Cirkel, a German engineer of experience and ability. Mr. Cirkel has spent some time in his native country making a careful study of the processes in use there, and his plans have been matured with a full knowledge of the most successful German processes, studied in relation to the character of the Black Donald ore.[1] It is perhaps inevitable that defects will be found in the method adopted, and improvements will likely be made as experience is gained in treating the ore; but in a general way it may be described as the wet treatment, with a chemical process for extraction of the lime—the main object being to separate as completely as possible the flake from all other parts of the ore. It was late in the year before the mill was ready for work, and as only 70 tons of ore was put through the process a detailed description is deferred. The machinery of the mill is driven by power derived from Chaudière falls on the Ottawa river, and it has a capacity of treating four tons per day, but pro-

[1] An average of five analyses of the ore gives the following as the chief components:

Graphite	79.20
Oxide of iron	0.63
Carbonate of lime	9.14

It contains also fine particles of greenish white mica, which adds to the difficulty of the refining process.

vision is made for its enlargment. The cost for building and machinery complete was about $15,000. The company organized to carry on the works at the mine and mill is known as the Ontario Graphite Co., Limited, and its officers are S. H. Fleming, president, George P. Brophy, vice-president, and Hector McRae, secretary-treasurer, all of Ottawa.

PIG IRON AND IRON ORE.

First year of the Hamilton blast furnace.

The iron furnace in Hamilton was completed late in December of 1895 and the fires were lighted on the last day of that month, but iron was not actually produced until 2nd February following. Its first campaign had a duration of 82 days (2nd February to 6th May), and its second a duration of 159 days (23rd June to 21st December), being an aggregate of 241 days in the year, and in that time it smelted 51,138 tons ore and 5,883 tons mill cinder, producing 28,302 tons pig iron.[1] There was used in the reduction of ore 30,348 tons coke fuel and 8,657 tons limestone for flux. Difficulty was experienced in procuring ores of suitable quality in Ontario, as owing to the want of a local market few mines had been opened, and therefore a large proportion of the ore smelted in the furnace was brought in from United States mines. The actual figures were 35,868 tons American and 15,270 tons Ontario ores, the latter being a mixture of magnetic, hematite and bog ores, and the greater part of which were raised during the year. The furnace employed an average of 125 men and the amount of wage earnings was $47,000, which of course does not include the wages of men employed quarrying limestone, mining ore or handling materials delivered by rail to the works. The total value of the pig iron product, based on the selling price at the furnace, was $353,780.

Prospecting for suitable ores.

The opening of this furnace having established a market for ores of good quality, prospectors have been actively employed in searching the Province for them. Magnetic ores are plentiful in some eastern counties, but a number of the properties which have been worked yield an ore too high in sulphur for the production of a high grade of iron. Hematite and specular ores are preferred by the superintendent of the furnace, and it is stated that valuable discoveries of these ores have been made in the townships north of lake Huron, back of Bruce Mines. These deposits are being explored and developed, and it is confidently expected that during the present year large supplies for the furnace will be procured from that quarter. In the eastern counties hematite ore is not known to exist in large quantity or very generally, but there are a few deposits where ore of this class has been found of a fine quality. One of

Playfair mine.

these is known as the Playfair mine, in the township of Dalhousie. It was worked many years ago and the ore shipped to Cleveland, but owing to the heavy charge for transportation the business did not prove remunerative and the mine was closed down. It is not certain whether any large body of ore remains, but the property is worth investigating. Partly to call attention to it and invite a careful prospecting of the district, and partly to preserve an historic record of the enterprise, the following account of the Playfair mine

[1] In each case it is the net ton of 2,000 lb.

has been furnished to the Bureau by Mr. Alexander Cowan of Toronto, under whose management it was opened. Mr. Cowan's memorandum was written under date of November 21, 1896:

In compliance with your request that I would give you full particulars regarding what is known as the Playfair hematite iron mine, I beg leave respectfully to submit the following: The Playfair mine is situated on the east half of lot 1 in the fourth concession of the township of Dalhousie, county of Lanark, and is 12 miles distant from the town of Perth. The strike of the bed of iron ore is northeast by east, and the dip is an angle of 45 degrees. Work was commenced at this mine in 1866 under the management of the writer, on behalf of the owners, Messrs. David Torrance & Co. of Montreal, J. B. I. Robinson of Newark, N.J., and myself, then of Brockville. Under this management work was continued till 1871, the number of men employed being an average of say 25. The iron ore was found lying between beds of crystalline limestone. The lode was very irregular in width, running from 5 feet up to 11 or 12 feet in places, the average width being say 7 feet. The total quantity of ore mined during the five years was close upon 10,000 tons of 2,240 lb. This ore was shipped to Messrs. Rhodes & Company of Cleveland, Ohio, of which Mr. Mark Hanna of McKinley fame was then manager. The ore ran on an average of 60 per cent. metallic iron, and was considered one of the purest and most easily smelted of any ores shipped to Cleveland. The price paid for same was $5 per ton delivered at Cleveland. The ore was raised by means of six shafts which were sunk to the following depths:

Report of Alexander Cowan on the Playfair mine.

No. 1 shaft	68	feet deep.
2 "	49	"
3 "	25	"
4 "	20	"
5 "	45	"
6 "	29	"

The principal reason for the discontinuance of work at the mine was the great expense of hauling the ore 12 miles to the town of Perth by teams, which drew loads averaging over 4 tons, costing $1.70 per ton in summer and $1.10 in winter. But little of the ore was however hauled in summer. The cost of moving the ore was $1 per ton by rail from Perth to Brockville and $1 per ton by boat thence to Cleveland. Of course in each case the ton consisted of 2,240 lb. Such was the recognized excellent quality of the ore that had there been railway communication with the town of Perth work would have been continued by the owners, as the ore showed no signs of giving out. There are good reasons for believing that if a thorough test were made on this and adjoining properties under the direction of some one who knows the territory well, using modern appliances for boring in different parts, that many beds of ore would be discovered, probably larger than those already worked. ALEXANDER COWAN.

Indications of other deposits of hematite ore are to be seen at several points in the same locality, as well as in other parts of Lanark county, and the district is worthy of being closely prospected. With the local market which the Hamilton furnace affords there ought to be substantial progress to record this year in the development of known properties, and no doubt new discoveries will be made in parts of the Province not hitherto prospected. In the townships traversed by the Irondale, Bancroft and Ottawa Railway bodies of magnetic ore have been found, some of which are of large extent, and years ago shipments of ore were made from two or three of them to the United States. It is hoped that operations along that line will soon be renewed.

Occurrences elsewhere.

NICKEL AND COPPER.

Comparative statistics of ore raised in the years 1892-6.

The following table presents for the five years 1892-6 the quantities of ore of nickel and copper raised and smelted, and the per cent. of metallic contents in the smelted ore :

Year.	Ore raised, tons.	Ore smelted, tons.	Per cent. of metallic contents in ore smelted.		
			Nickel.	Copper.	Cobalt.
1892	72.349	61.924	3 36	3.19	.1007
1893 ..	64.043	63.944	2.21	2 38	.0800
1894.....	112,037	87,916	2.92	3.14	.0721
1895	75,439	86.546	2 67	2 73	.....
1896.....	109,097	73,505	2 67	2.54	.....

The statistics of ore raised are for the mines of three Companies, one of which was carrying on development work upon a copper-bearing vein, and the statistics of ore smelted are for the works of two Companies, one of which had enlarged its plant during the year. The works of two Companies which had closed down in 1894, owing to the death of the principal man in each, were idle last year also ; but it is expected that operations will be resumed at one of them during the present year. It will be noticed that the quantity of ore raised last year was nearly equal to the output of 1894, and much larger than in any one of the other three years of the period. The quantity smelted was less than in the two preceding years, although larger than in the first two years, and the production of metal was very nearly the same as in 1892, although considerably less than in 1894 and 1895. The mine whose ore carried cobalt has been idle during the last two years.

Comparative statistics of the industry in 1892-6.

The next table gives the comparative statistics of the industry for the same period :

Schedule.	1892	1893	1894	1895	1896
Ore raised ... .tons	72,349	64,043	112,037	75,439	109,097
Ore smelted .... "	61,924	63,944	87,916	86,546	73.505
Ordinary matte ...... "	6,278	7,176	10,410	12,525	9,733
Bessemerized matte .. "	1,880	452	1,470	103½	....
Nickel contents ...... "	2,082	1,653	2,570½	2,315¾	1,948½
Copper contents ..... "	1,936	1,431	2,748	2,365½	1,868
Cobalt contents ...... "	8½	19	3¼	....	....
Value of nickel ....$	590,902	454 702	612,724	404,861	357,000
Value of copper ... .."	232,135	115,200	195,750	160,913	130,660
Value of cobalt ...."	3.713	9 400	1,500	....	....
Wages paid ... ."	339,821	252,516	311,719	209,960	247,151
Men employed	690	495	655	444	485

Statistics of total quantities for the five years.

In the five years the total quantity of ore raised from the mines has been 432,965 tons and the quantity smelted 373,835 tons. When reduced to matte, in which form it is shipped to the refineries, the weight is 50,027½ tons, of which 46,122 tons is ordinary and 3,905½ tons is bessemerized matte. In the latter state it carries a much larger per centage of the metals ; but for some reason the process appears to be going into disuse. At the refineries,

where the fine metals are extracted, the bulk of the 373,835 tons of ore treated is further reduced to 20,949 tons, made up of 10,569¾ tons nickel, 10,348½ tons copper, and 30¾ tons cobalt. As matte the weight has been reduced in the proportion of one ton to seven, and as metal in the proportion of one ton to eighteen. For the five years the average of metallic contents of the ore has been 5.6 per cent., the nickel being 2.83 per cent and the copper 2.75 per cent , which is slightly higher than the average of each of these metals in the ore treated last year. The total value of the product of the mines for the five years, computed at the selling price of matte at the smelting works, has been $3,269,460, whereof the nickel represents $2,420,189 or three-fourths of the whole, the copper $834,658 and the cobalt $14,613. The earnings of labor employed in this industry for the five years have been $1,361,167 or nearly 42 per cent. of the value of the product, and the average number of men employed at the mines and works has been 554. At the average cost of $272,233 per year for labor, the average earnings of each man in the whole period of five years has been nearly $492 per year, although at some of the works steady employment has not been given.

Comparative values of metallic contents for the five years, based on the selling price of matte at the works, are presented in the following table : Comparative values metallic contents.

Year.	Nickel		Copper		Cobalt	
	per ton.	per lb.	per ton.	per lb.	per ton.	per lb.
	$	cents.	$	cents.	$	cents.
1892	285 81	14 290	119 90	5 995	436 82	21 841
1893	275 08	13.754	80 50	4 025	494 73	24 736
1894	238 36	11 918	71 23	3.561	461 54	23 077
1895	174 83	8.741	68 02	3 401		.....
1896	183 22	9 161	69 94	3 497	....	....

The average prices of last year are slightly higher than those of 1895, but much below those of the three previous years.

Statistics of employes of the mines and works for each of the five years are furnished in the next table, classified as workers above and below ground according to ages, as regulated by the Mines Act : Statistics of labor and wages.

Year.	Workers of 15 to 17 years		Workers over 17 years		Total workers.	Total wages.
	above ground.	under ground.	above ground.	under ground.		
						$
1892 ...	10	....	488	197	695	339,821
1893.....	10	....	356	129	495	252,516
1894	17	....	395	243	655	311,719
1895	7	....	341	96	444	209,960
1896	8	....	297	180	485	247,151

The average wage earnings per man last year was nearly $510, being $18 more than the average for the five years. There has been however a falling off in the average value of product of the works per man employed when

compared with previous years, the average being only $1005 as against $1285 in 1895, $1236 in 1894, $1170 in 1893 and $1197 in 1892. For the five years the average value of product per workman has been $1180 per year. The explanation is to be found in part in development work undertaken which gave no result in production of matte, but chiefly in a falling off in the production of matte at the smelting works.

NICKEL IN TARIFF HEARINGS AT WASHINGTON.

Enquiry before the Dingley Committee at Washington as to the necessity of a duty on nickel and nickel ores.

Before the Committee on Ways and Means at Washington in January of this year the question of a duty on nickel and nickel ores was investigated, and a lengthy statement was made on behalf of nickel producers in the United States by Hon. Binger Hermann, a representative from the State of Oregon. Mr. Hermann claimed that large quantities of nickel bearing ore are to be found in his own State, as well as in the States of Washington and North Carolina, and on behalf of the owners of mining properties he asked for a duty of 10 cents per pound on nickel. He affirmed that when the duty was taken off nickel ore and matte in 1890 the existence of nickel in the United States was well known in the States here mentioned, and that subsequent developments have shown that it is to be found in very large quantities. "In my own county," Mr. Hermann said, "there is a vast mountain with a vein at least twenty feet in width within three miles of the Southern Pacific Railway." Proceeding, he affirmed that the mine owners in his county "are able to produce the nickel itself at a price four cents less than they can produce the Canadian nickel."

Hon. Binger Hermann's statement.

Mr. Dolliver: I noticed the Act of 1883, which put a duty of 15 cents a pound on nickel, reckons it on the nickel contained in the ore and not on the ore itself.

Mr. Hermann: I understand that is regulated very largely by the quantity of nickel which is contained in the ore.

Mr. Dolliver: I understand you think the duty should be put on the metal and the ore should be left on the free list?

Mr. Hermann: So far as the ore is concerned? No, sir; I think not. We would not think of that at all, because very often it would be a great injury to the development of our nickel mines of the West.

Mr. Tawney: Have you any figures showing the cost of producing that ore in Canada as compared with the cost of producing the ore here?

Mr. Hermann: Except simply the statement I have made here that it can be produced in the United States for four cents less per pound than in Canada.

Mr. Turner: It can be produced in your State—

Mr. Hermann: For four cents less than it can be produced in Canada.

Mr. Turner: What do you want with a duty then?

Mr. Hermann: Simply for the reason that the ore coming free, as it is at the present time, there is no encouragement whatever to our people.

Mr. Turner: If you can beat them at the rate of four cents a pound, it would seem you would have to give a bounty to get it to come at all?

Mr. Hermann: Just as soon as we are left open entirely, as at the present time, combinations at once form upon the part of the foreign producers, so as to stifle and at once drive out our own people. We have discovered that.

Mr. Steele. How could they be driven out if you could produce it for four cents less than they can in Canada?

Mr. Hermann: If, after a while, we have protection, I am satisfied we can hold our own. In the meanwhile there must be some protection.

Mr. Evans: What do you need protection against if you can produce it in this country four cents cheaper than they can in Canada?

Mr. Hermann: Well, I am speaking now of the producer at that particular locality, and also in North Carolina. These localities are remote from transportation, and as to railway

transportation it is so costly when you take the difference between rail transportation to the East and to the communities where the nickel ore is used, you will find at once the difference will far overset that of the ordinary duty. And so far as the manufacture of the nickel itself right upon the ground, I admit it can be done there much cheaper than it can anywhere else, but it is upon that point they make their basis of the four cents difference. But when we take into consideration the very costly transportation between the far Pacific and the East—

Mr. Hopkins: Where a mine has been located and found to produce ore in paying quantities a rate of duty is more to stimulate the development of the mines?

Mr. Hermann: And, further, I will say to my friend, there is this great obstacle in the way at the present time which I referred to, and that is the great charge of transportation and the distances from the East.

Mr. Turner: Would not a charge of anything like four cents a pound bring the ore from your country to the East?

Mr. Hermann: The transportation charges are very great between the extreme portions of the Pacific and the Atlantic.

Two witnesses were heard by the Committee in reply to the statements of Mr. Hermann, one of whom was Robert M. Thompson, manager of the nickel and copper refining works at Constable Hook, New Jersey, and the other Mr. Stevenson Burke of Cleveland, president of the Canadian Copper Company. Mr. Thompson was heard immediately after Mr. Hermann, and put in a supplementary statement later on.

Statement of Robert M. Thompson of the Orford Copper Company.

Mr. Thompson said: Mr. Chairman and gentlemen of the committee, I am a nickel refiner and have refined all the nickel that has been delivered to the Government. The Government is the principal purchaser of nickel in the United States. At the time referred to, when the Secretary of the Navy was seeking to obtain nickel, the price of nickel in the markets of the world was about 60 cents a pound. As soon as this enquiry came upon the market it advanced to $1 a pound. The Canadian Copper Company, in which I have not a penny of interest, was owned and controlled by a number of American citizens, among whom was Senator Payne of Ohio. They came forward and sold to the Government the supply of nickel at 11 cents a pound in the matte, purely as patriotic a thing as was ever done by any set of men in America. In my business of refining I am anxious to buy my supplies in the cheapest market. I have had all the mines this gentleman referred to examined by experts. I am familiar with all these deposits in these various States to which he has referred. There is not one of those mines to-day where they can be made to pay at any reasonable duty. If they were I would be in the ownership of them. As a matter of fact, the nickel market as compared with the ordinary metal market is a baby one. We deal in ounces almost where other metals deal in tons, and you have got to have the metal in some position where it can be treated, and the great cost is in the treatment of the ores. These Oregon ores are a silicate and refractory nickel. Now, in regard to the transportation to the eastern coast, they are bringing from that section of country—Butte, Montana,—an enormous quantity of copper matte, the freights on which are from half a cent to six tenths of a cent a pound, or from $10 to $12 a ton. That would give the cost of transportation. But the fact is these oars cannot be treated economically. Mr. Wharton of Camden, New Jersey, is another nickel refiner, and both he and myself, and he especially, have been in anxious pursuit in America of nickel, and if such a thing can be found Mr. Wharton would be here to advocate an increased duty as the owner of that deposit. If you put that duty in the bill it is simply the American Government would have to pay the duty. The consumption outside the Government for steel purposes is perhaps 300 or 400 tons in the whole United States.

The Chairman: You have examined personally these California, Nevada and Oregon deposits?

Mr. Thompson: I have had them examined by experts; not personally. I have had them examined by experts who were more competent to examine them.

The Chairman: What seems to be the difficulty in respect to these mines?

Mr. Thompson: The ores are very much scattered there, and to a ton of rock moved the ore will be very low in grade. You can find samples of rich ores in a deposit, but after it is obtained it is very difficult to treat; the expense of extracting the ore is very great. Nickel is called one of the refractory metals. It is very hard to treat. In Nevada the deposits are in pockets. Occasionally you find a small pocket containing 10, 15 or 20 tons of very rich ore. In some of these pockets you will find ores so rich there is no price at which they would

not mine and ship it. Now the assaying of nickel is a very difficult thing, and local assayers not accustomed to assaying nickel are constantly making mistakes, and I have had reports that such a mine had an enormous deposit of very rich ore. I would send experts and have careful samples sent on and find out there is not a trace of nickel in it. That has been my experience. I have spent in the last year not less than $5,000 on an expert who has been travelling over the country from place to place all the time in my anxiety to find a supply. I should be glad if any gentleman will find it for me.

Mr. McMillan: Do you concur in Mr. Hermann's statement when he says that nickel ore can be produced in Oregon at four cents per pound less than it can be produced in Canada?

Mr. Thompson: He is in error in his statement. He has undoubtedly been told so by persons interested in the property. Those ores of Oregon resemble in their nature the ores of New Caledonia belonging to the French company. Those ores in New Caledonia run a maximum of 7 per cent., and a mine which will pick up to 9 or 10 per cent. in competition with the Canadian ores would practically drive them out of the market.

Mr. Hermann: I will ask the gentleman whether or not it is a fact there is considerable cost in the extraction of copper, which forms a very material part of the nickel of Canada, as against that found on the Pacific coast, wherein there is a very little trace of copper? I am so informed.

Mr. Thompson: The reason why the Canadian ore can be sold so cheaply is, it contains such an amount of copper ore—you can call it nickel ore or copper ore, as you choose—and because the copper is a source of material value has been the reason why they could sell their ores so cheaply. The United States Government when they made their purchase paid for the nickel 11 cents per pound and 4 cents for the copper in the ore, and then turned around to the refiner and sold that copper at 6 cents a pound, making a profit on the transaction.

Mr. Wheeler: Will the gentleman state the extent of the mines in Canada?

Mr. Thompson: They are very large, and they belong to a number of parties. There are a number of deposits of ore there. One company is the Canadian Copper Company, of which Judge Burke here is president.

Mr. Wheeler: Are the mines of the Canadian Copper Company owned entirely by Americans?

Mr. Thompson: Yes, sir; and in treating ores I wish to say they use American coke.

A supplementary statement.

Subsequently Mr. Thompson supplemented his information to the Committee with the following statement:

If a duty of 10 cents per pound were placed on nickel in ore, this would not raise the price of refined nickel 10 cents unless the duty on the refined nickel was also increased. The actual facts of the nickel trade are these: The estate of Senator Payne, the estate of Cornell of Akron, Ohio, and Judge Burke, Cleveland, are the principal owners of certain nickel deposits in Canada. They produce there a matte carrying copper and nickel at a cost to themselves of about $25 a ton of matte. All of this matte is shipped to our works in New Jersey for treatment, and of the railroad freight about one-half goes to the Canadian roads, making a total expenditure per month, under present conditions, of about $28,000 expended in Canada. On the other hand the expenditure at my works and at those of Joseph Wharton of Philadelphia, and to the American railroads for transportation amount to about $100,000 per month. You will thus see that the interest of the United States is four times as great as that of Canada in the working of these mines. Of the nickel brought into the United States for treatment, about one-third is consumed in this country, and one-half of this consumption is by the United States Government direct. The consumption of nickel in the United States outside of the Government did not last year exceed 800,000 pounds. The effect of putting a duty upon raw material would be to at once transfer the refining of the Canadian nickel mattes to Liverpool; but this would not give the market to American ores, as the refined nickel would be shipped back here. But assuming that the American mines could be given the American market, it is about 800 tons of nickel a year. The gentleman from Oregon was quite sure that it could be produced cheaper than the Canadian production. Assuming that it could be produced at the same cost, it would represent an expenditure of about a little over $9,000 a month, say $110,000 a year. In order to secure the expenditure of this $110,000 a year in America, it would be necessary to tax the consumers of America $160,000 a year, of which $80,000 would have to be expended by the Government direct. On the other hand we would lose the expenditure of money now made in refining nickel for the foreign market, say one-third of $100,000 a month, or $400,000 a year. Naturally the American labor would not be benefited by this transaction. The fact is that nickel is a small m

special business, and can not be placed upon the footing of any of the great industries which employ large numbers of men.

Statement of Mr. Stevenson Burke, President of the Canadian Copper Company

Mr. Burke said: Mr. Chairman and gentlemen of the committee, I am president of the Canadian Copper Company, and therefore may be presumed to know something about it. I wish to say this, that the Canadian Copper Company, so called, is an Ohio corporation, incorporated under the laws of Ohio, with possibly one little stockholder in Canada holding perhaps 100 or 200 shares of stock; but it is absolutely an Ohio corporation, and the property was developed altogether by Ohio capital. The mines are owned in fee simple by the corporation. The land itself was purchased out and out, and I wish to say that, for the very purpose of having the Government and the people of the United States get the benefit which would come from the use of nickel as a component part of steel, I myself, on behalf of this corporation, sold to the Secretary of the Navy, not ore, but matte, nickel matte, at 11 cents a pound for the nickel contained therein, while within a month of the same time before that we had sold to a French company the same kind of nickel product at 22 cents, or a trifle over, per pound. We desired to have the nickel tested for the purpose of its being used for armor plate. I wish to say it was our company which suggested to the Secretary of the Navy the use of nickel steel for armor plate. I wish to say in addition that every pound of this nickel is refined, and that the chief labor of that is in this country. The amount of money paid out to laborers in that respect the past year would be about $300,000; and of course the putting of a duty upon either nickel ore or nickel matte would result necessarily in the refining of this product in Canada, or in Great Britain, or in Germany. For instance, at the time this question came up in 1890 or 1891, the matter was investigated, and the company with which I am connected was selling its nickel matte at that time in Germany and in Great Britain; and I wish to say at the present moment we are offered by a very prominent Englishman—a man who has very great wealth and who has a process of refining this nickel—a market for every pound of nickel matte we have—every pound of it. We have preferred to have this work done in this country. We have preferred to give our people the benefit of it; and inasmuch as our institution is absolutely an American institution in every respect, an Ohio corporation with Ohio stockholders, and the property over there owned in fee simple—and we are treated exceedingly well by the Canadians, so far as I have any reason to know—we do not see any special need of practically destroying as far as possible the investments of Americans in Canada. Of course, if a duty should be put upon nickel ore or nickel matte, why that is the end of its coming to this country. Instead of that it goes to England, Germany, France, and elsewhere to be refined. Then I wish to say in addition to that, that if these gentlemen have nickel as rich as they talk about, then they do not need any protection. Of course I do not believe their story that they have any nickel as rich as that. They say the nickel runs from 10 to 15 per cent. on the average. I can show you samples from our mines of nickel ore running 54 per cent.; and I wish to say in that connection the average is only about 3 per cent. Of course you can find rich samples anywhere of products of this kind. Now in view of the fact, it seems to me it would be wise to allow these people to demonstrate with their money that they can supply the Government with that nickel or nickel oxide that it needs in its armor plate; that they should show that they have put up smelting works, put some money into the institution here; and if they have as rich ore as they talk about, let them put up their refineries and treat the ore there. Assuredly nickel itself is worth moving even upon cars across the continent where nickel ore may not be.

Mr. Hermann: Just one enquiry. Before 1890, when nickel ore was placed on the free list, you were unable in Canada to compete with the nickel mine owners of the United States.

Mr. Burke: No, sir; we supplied these men absolutely with our matte.

The problem of nickel refining works in Canada.

The statements of Messrs. Thompson and Burke were no doubt meant to persuade the Dingley Committee of the wisdom of the provisions of the existing tariff, under which protection is given to nickel refined in the country, while the raw ore and matte containing the metal are imported free. But the United States is not the only country in which there is a market for nickel, and while Congress may frame a tariff to secure the greatest good to Americans, it cannot check enterprise elsewhere. The most natural suggestion that will arise in the minds of Canadians who may read the statements of Messrs Thompson and Burke is, not of the possibility of a development of

deposits of nickel ores in the United States, but rather of the possibility of producing refined nickel and copper from the ores of Ontario mines. If it is true that the labor cost of raising a certain quantity of ore and reducing it to matte is only $28,000 per month or $336,000 a year, while the cost of extracting the metal contents is $100,000 per month or $1,200,000 a year, it is worth enquiring whether the more expensive and probably the more profitable part of the industry might not also be carried on in the country which supplies the raw material. There are other processes of refining besides those in use at the Orford Copper Company's works, as was intimated by Mr. Thompson, and the natural advantages of the industry are as great on this side of the line as on the other. They are probably greater, if account is taken of the lower cost of labor and the saving on transportation, and enterprise and capital in Canada should be found equal to the opportunity. As far as an opinion can be formed now, there is likely to be a steady and growing demand for nickel, and the refining business will expand with every advance made in cheapening the production of the metal. The question of tariffs, and how they may be best adjusted to aid an industry, is one for Governments and Legislatures to consider.

EXTENDED USES OF NICKEL AS AN ALLOY WITH STEEL

Adoption of nickel steel as armor for vessels of the British navy.

As an alloy with steel, nickel is growing steadily in favor wherever lightness and tensile strength are required. In the manufacture of bicycles alone there is a good demand for it, and some of the largest works in Great Britain, the United States and Canada are using nickel steel for the framework of bicycles. There are many other purposes for which it is used ; but no doubt the principal one is armor plate for battleships. The officers of the British navy have been slow to appreciate the value of nickel steel for this purpose, but the adoption of it by the naval authorities of the United States and the orders given by the Government of Russia for ships armed with nickel steel plate, and especially the good results of tests made last winter at the works of three armor plate manufacturers in Sheffield, decided the question for the British authorities. In the month of March trial was made of a 6-inch nickel harveyed plate measuring 8 by 6 feet, made by Vickers, Son & Co., when it was fired at by a 6-inch B. L gun with the full charge of 48 lb. of powder, giving a striking velocity of 1,960 foot seconds, the distance of the gun from the plate being 30 feet. After the five rounds required to fulfil the conditions no cracks were formed ; all the projectiles were broken to small pieces, and only two fine surface cracks developed. The projectiles used were Holtzer service of 100 lb. weight, and the actual penetration measured by the points of two of them jarred out of the plate was only 1½ inches. A sixth shot fired at the request of the makers gave a result practically the same as before ; slight surface cracks showed around the point of impact, but otherwise the plate was undamaged.[1] Five years ago many tests were made under the direction of officers of the Admiralty, ending in 1893 in the adoption of harveyed steel as the most efficient material of defence for the vital parts of any ship of war ; but the later tests have so conclusively established the

[1] Industries and Iron, March 26, 1897.

superiority of nickel steel armor over all others that the Government has agreed to adopt it in arming the new vessels whose construction has been ordered this year. As this report is going through the press the announcement is made by the First Lord of the Admiralty, Mr. Goschen, that the main armor of three battleships of the Majestic class (14,900 tons) as well as of four cruisers (11,850 tons), is to be constructed of nickel steel. This decision will doubtless have far-reaching effects, and will tend to largely increase the demand for nickel.

GOLD.

The statistics of gold mining in the Province for the past five years are given in the following table :

Statistics of gold mining for the five years 1892-96.

Schedule.	1892.	1893.	1894.	1895.	1896.
Mines worked..........number	9	15	4	8	8
Men above ground...... "	85	112	40	126	103
Men under ground...... "	40	56	52	111	86
Ore treated ....tons	3,710	5,560	2,428	6,500	13,292
Gold product ....oz.	....	1,695	2,022½	3,030	7,154
Gold value ....$	36,900	32,960	32,776	50,781	121,848
Wages paid for labor ...."	22,750	49,027	38,032	56,234	91,210

Although these statistics represent eight mines which produced bullion last year, only two of them were worked steadily, and in the case of one of these the mill was run only in the day time. The average product of the ore was $9.16 per ton, as much lean ore was treated owing to the lack of development work. One mine, the Mikado of Shoal lake, has given the best results yet obtained in Lake of the Woods region, being an average of 3.26 oz. or $48.94 per ton from a run of 297 tons treated at the Reduction Works of the Dominion Gold Mining Company at Rat Portage. The total number of stamps in operation last year was 45, but with new mills in course of construction and additions to one or two of the old ones it is probable that 130 stamps will be dropping before the close of the present year. Statistics of working mines however do not give a fair idea of the extent to which operations in the gold fields of the Province are being carried on, especially during last year, as the returns do not take account of development work upon locations where no mills have been erected for treating the ores It is important to know the extent to which such work has been undertaken, as it bears closely on the probable future of our gold mining industry, and with this object the following record has been prepared, the data in the case of each property having been supplied by the owners or managers according to schedules prepared by the Bureau.

RECORDS OF DEVELOPMENT WORK

Mikado mine.

The Mikado mine, or mining location 148D, is owned by the Mikado Gold Mining Company, Limited, of 79 Gracechurch street, London, E. C., England. It is the property whose unusual richness has given prominence to the Shoal Lake (west) district, and which enjoys the reputation of having practically paid for itself in bullion and ore from the start, nc uding a return

of the purchase money paid by the present owners, $25,000. On it are situated two parallel lodes, 400 feet distant, the course of the veins being 35° south of east. On the west or No. 1 vein an open quarry has been made on the outcrop, 150 feet long, 20 feet deep and 10 feet wide. A shaft 6 feet by 12 in size has been sunk on the hanging wall side 38 feet east of the vein, which at the end of the year had reached 70 feet in depth. At 60 feet a crosscut 4 feet by 6 was run towards the vein, which was struck at a distance of 34 feet from the shaft. The work of driving on the vein to right and left at this level had just begun. An open working, 70 feet long, 15 feet deep and 10 feet wide, had also been made on the east or No. 2 vein. Operations were begun August 1st, 1896, and a force of sixteen men employed throughout, the expenditure for wages during the year being $4,747.77. The machinery in place at the close of 1896 consisted of a locomotive boiler of 40 h. p. and hoisting engine, double cylinder and double drum of 30 h. p. The manager is Mr. Theo. Breidenbach.

Sweden mine.

The properties owned by the Sweden Gold Mine Company of Ontario, Limited, whose head office is at Winnipeg, Man., are D58 and 447P. There are on these locations five veins, four of which run northeast and southwest, and one north and south. Work was begun by the present company in October, 1896. On No. 1 vein a shaft 7 feet by 9 had been sunk to a depth of 70 feet, and a drift of 10 feet had been made along the vein. A crosscut had just been begun. Veins Nos. 2 and 3 had both been stripped for some distance, on the former for about 100 feet, and a pit 10 feet deep sunk on each. Seventeen workmen were employed, and about $1,200 had been paid out in wages up to the close of the year. The original discoverer of the locations was a prospector who had put down a shaft a depth of 30 feet before the present company acquired the property. The work had so far been done by hand, but arrangements were being made to put in machinery to assist in development, and probably also a stamp mill. Mr. Charles E. Carbert is secretary-treasurer of the company.

Nonesuch mine.

Mining location M12, called the Nonesuch mine, is owned by Oliver Daunais of Norman. The vein on the property, whose course is northeast by southwest, is of unusual size. Work was begun in July, 1895, and continued till May, 1896. A shaft 6 feet by 9 was sunk to a depth of 70 feet. At 60 feet a crosscut was made to determine the width of the vein, which at that depth was found to be 40 feet. From five to eight men were employed during the above period, and the total amount expended for wages, tools, powder, buildings, etc., was $3,500. Twenty-five or thirty feet of drifting has been done on an extension of the same vein, on location M14.

Three Ladies mine.

The Three Ladies mine belongs to the same owner. On this property there are two parallel veins about 150 feet apart. On one vein two shafts have been sunk at a distance from each other of about 600 feet, the shafts being of the dimension of 6 feet by 7. One is 57 feet deep, and the other is 28 feet. The first shaft showed the vein to have a width of 2 to 3 feet and the second a width of 4 feet. On the second vein a shaft of the same size was sunk to a depth of 30 feet, the vein at the bottom being 6 or 7 feet wide. This work was done in 1889 and 1890.

Dining Tent at Proudfoot's Camp, Upper Seine River.

The Forge in the Forest, Proudfoot's Camp.

Indian Nursery at Sawbill Lake—a Snap Shot.

An Indian Canoe Factory at Sawbill Lake.

The Three Friends mine also belongs to Mr. Daunais. There are two veins, on one of which a shaft was sunk in 1890 and 1891 to a depth of 45 feet, which showed the vein to be about 3½ feet wide. About 25 feet of stripping and 50 feet of drifting was also done on this vein. In all some $6,000 to $7,000 has been expended by Mr. Daunais on the Three Ladies and Three Friends. Three Friends mine.

The Scramble mine, which is situated on lots 13 and 14 in the sixth concession of Jaffray, is owned by L. W. Partridge and E. D. Williamson of Detroit, Mr. S. V. Halstead of Rat Portage being manager. There are eight veins on the property of which five run about northeast and southwest, one nearly east and west, one north and south and one nearly southeast and northwest. Considerable prospecting work was done by Mr. A. Benson, the former owner, during the summer of 1895. The present proprietors began work in November of that year. A shaft 7 feet by 11 had been sunk on No. 1 vein a depth of 54 feet, and at the 50 foot level a crosscut 5 feet by 7 had been made running across the vein 27 feet. About 500 feet of stripping has been done at various points on this vein. Small test pits have been sunk on veins Nos. 3 and 4, and some stripping and blasting have been done on other veins. An average of nine men were employed, and about $1,200 was paid out for wages during 1896, or about $1,500 in all up to 31st December of that year. A pulsometer pump was in place, but the management was contemplating the formation of a joint stock company and the erection of a stamp mill. Scramble mine.

The Norway mine, situated on mining location 395P, is owned by Mr Walter Ross of Rat Portage. Several veins occur on this property, and some development work was done in 1893, a shaft 7 feet by 9 having been sunk 50 feet, and several crosscuts made. About $1,800 in wages were paid out for work on this location. Norway mine.

Mining locations 504P and 589P are situated on Bath island in Lake of the Woods, and are owned by a syndicate of Toronto gentlemen, John Galt, C. E. and M. E., being chairman. Seven parallel veins running east and west have been explored, and intermittent work on these has been done since 1895. Some drifting has been done on the south vein; seven test pits and a shaft 18 feet deep sunk on No. 1 vein; a shaft 7 feet by 9 sunk to a depth of 28 feet on No. 2 vein; one cross trench run on No. 3 vein; two test pits sunk on No. 5 vein, and seven test pits on No. 6 vein. About $1,500 has been paid out in wages, and the actual outlay for mining expenses, buildings, etc., has been about $5,000. The only machinery on the island consisted of horse-power hoists. Bath Island mine.

Messrs. R. H. Ahn and Company of Rat Portage had two properties under development at the end of the year. One of them, called the Standard mine, is on mining location McA51. Two lodes occur on the property, one 3 and the other 26 feet wide. Work was begun in October, 1896. No. 1 vein was stripped for 150 feet, and a shaft 8 feet square was sunk to a depth of 25 feet. Twenty tons of ore were on the dump from this vein, the average of assays being $15 in gold per ton. No. 2 vein was crosscut the entire width to a depth of 10 feet, the cut being 6 feet wide, and a shaft was started on the hanging wall. Sixty tons of ore had been taken out, assaying from Standard mine.

$6 to $15 per ton, which it was intended to ship to the Reduction Works at Rat Portage in the spring. A force of six men was at work continuously from October, the average wages paid being $1.50 per day and board. It was proposed to erect a ten stamp mill on the property in 1897.

Queen mine.

The same firm was also engaged in developing the Queen mine, situated on mining location McA46, on which are two veins 5 feet wide running respectively south 70° west and south 50°. Operations were begun December 2nd, 1896, and one shaft put down 15 or 20 feet on each vein. Surface assays showed a value of $2.50 per ton, which increased at the bottom of the shafts to $11.50 per ton. Five men were employed at the average wages of $1.50 per day and board.

Gold Hill mine.

On the Gold Hill and Black Jack mines, owned by the Dominion Gold Mining and Reduction Company of London, Eng., a force of 20 men was employed from the end of October, 1896. On the Gold Hill a shaft has been sunk on the Pebble vein 120 feet deep, and about 50 feet of drifting has been done at the 50-foot level. A shaft which is 6 feet by 8 was being sunk to 150 feet, from which depth it was proposed to run a crosscut 60 feet to reach a rich vein lying to the north. A steam hoist brings the ore to the surface.

Black Jack mine.

On the Black Jack a shaft 6 feet by 8 has been sunk to 100 feet, and about 50 feet of drifting and 150 feet of crosscutting done. There is a steam hoist and also a ten stamp mill on the property. The average rate of wages paid to the workmen was $1.50 per day and board.

Reduction Works.

This company owns the Reduction Works situated at Rat Portage, the manager of which is Mr. R. H. Ahn. These works are now in good shape for treating customer's ore. The plant consists of four batteries of five stamps each, sample grinders, Cornish rolls, one Frue vanner, two Krupp vanners, two Colorado perfection concentrators, etc.

Cornucopia mine.

On mining locations D212 and D265 is situated the Cornucopia mine, owned by the Anglian Mining and Finance Company, Limited, of London, Eng. The situation is on Bag bay, Shoal lake, about a mile west of the Mikado. One vein runs northwest and southeast, and is from 3 to 4 feet wide; another runs northeast and southwest, and has a width of 3 feet. A shaft 80 feet deep had been sunk on No. 1 vein and a hoisting plant installed. Twenty men had been at work from October, 1896. A mill run of 25 tons of ore was made at the Rat Portage Reduction Works, and is said to have given the richest yield to date of any mine in the district. Vigorous development was contemplated by the managers, Messrs. R. H. Ahn and Company, and it was proposed to put up a mill at an early date.

D228 and D213.

Messrs. R. Cameron and Company of New York are the owners of D228 and D213. On the former location are two veins, one running east 10° north and the other northwest and southeast. The first is 3 feet wide, and has been stripped for 150 feet, with one test pit sunk upon it to a depth of 30 feet. A mill run of 4 tons gave $9 per ton. No. 2 vein has been stripped for 100 feet and a test pit sunk upon it 20 feet deep. The average assay value of the ore is $7.50 per ton. On D213 are three veins. Test pits 15 feet deep have been put down on each. A mill run of 4 tons gave $8 per ton.

D214.

Location D214 is owned by Messrs. Kendall and Whiting of Rat

Portage. It carries one vein 5 feet wide whose strike is southeast and northwest. Twenty feet of test pitting has been done, and a mill run of four tons gave $7.50 per ton. The last three mentioned properties were worked conjointly by a force of 14 men who began operations in October, 1896.

Regina mine.

The Regina (Canada) Gold Mining Company was reconstructed in February, 1896, with an authorized capital of 150,000 shares of £1 each, of which 127,111 shares were issued credited with 17s. per share as paid. Calls amounting to 2s. per share have now been made on all of these shares. The holders of about 40,000 shares have voluntarily paid up in full, leaving as a reserve of capital 1s. per share on about 90,000 shares, and 22,882 shares still unissued. The mine is situated on mining locations 556P and 557P, Regina bay, Lake of the Woods, containing 77 acres. Under-water rights have been secured increasing the area of the property to 200 acres. A good deal of work was done, and many improvements of various kinds made during the latter half of the year 1896. The shaft house over the main shaft, destroyed by fire during the winter of 1895 6, has been rebuilt, and a washing and dressing room constructed for the employés on the north side. This room, and the walls of the shaft house and of the gallery are faced with sheet steel as a protection against fire. A fire extinguishing machine is also lodged in the shaft house. The hoisting drum has been fitted with a new pliable rope of crucible steel, 19 wire ¾-inch diameter, 300 feet long, whose breaking strain is 18 tons. The ore is raised in the shaft by tubs, maximum weight when full half a ton. The small undecked 4-ton steam launch Eleanor has been replaced by the powerful decked steamer Squaw of Ottawa, 60 feet long, 26 tons burden, having comfortable cabins and a speed of 10 miles an hour, thus enabling her to steam from Regina mine to the C. P. R. wharf at Rat Portage in four and a half hours. The following additions to the plant have been made: four wooden vats 10 feet by 7, for the treatment by the McArthur-Forrest cyanide process of the concentrates, one air compressor engine power for four drills, one air receiver, one 80 h.p. multitubular return flue steam boiler, and one steam sinking pump in main shaft. A complete cyanide process for treatment of the tailings has been installed in a new building 40 by 50 feet and 40 feet high adjoining the mill, capable of treating 30 tons daily by the McArthur-Forrest method. In this building are 10 wooden vats, some 13 by 7 feet and others 10 by 7, three steam pumps, two of them centrifugal, one steam engine for working pumps, circular saw, etc., one smelting and assay furnace, one saw bench and one circular saw. To the outside works have been added a large fuel shed built alongside the boiler house, a chute to convey cordwood from the fuel yard at the top of the hill to the boilers, an engineer's workshop, a storehouse for coal, lime, and similar supplies, an additional storeroom for provisions, about six new miners' cottages and a log house 24 feet by 24 for

Extent of workings at end of the year.

the accommodation of the engineers. On 31st December, 1896, the workings of the mine had reached the following stage:

Shafts.	Depth in ft.	Width of quartz in vein, ft.
Main shaft on No. 3 vein, 10 by 6 ft	230	8
Air shaft " "	34	½
West vein shaft, 10 by 6 ft	70	1½
Trial shaft on No. 1 vein, 10 by 6 ft	20	1
Total amount of sinking done	354	

Tunnels and levels.	Length in ft.	Width of quartz in vein, ft.
Tunnel on level with top of main shaft	214	1
1st level north, 60 ft. from surface	27	3
" south, " "	133	5
2nd level north, 108 ft. "	63	3
" south, " "	297	5
3rd level north, 185 ft. "	110	3
" south, " "	120	6
Total length driven	964	

The average width of solid quartz in the stopes above these levels is from four to five feet. The average value of this quartz, judging from assays taken twice a week during the last six months of the year, was 1 oz. 2 dwt. 17 gr. of pure gold per ton of 2,000 lb., the total number of assays taken being 123. The estimated amount of reserve of this class of ore in sight is 6,500 tons and was being added to at the rate of about 100 tons per day. Up to the end of 1896 4,858 tons of rock had been crushed in the mill, most of it coming from development work in the shaft and levels. It was therefore largely mixed with barren country rock. The total yield of bar gold from the time crushing began in September, 1895, to 31st December, 1896, was 1,341 oz. 8 dwt. Its value per ounce has steadily increased with the depth from £3 10s. 0½d. to £3 15s. 6d. The quartz in this mine is easily crushed, so that even with a fine (40-mesh) screen and high discharge the 10-stamp battery now in use can readily crush one ton an hour, or 24 tons per diem, the mill being worked night and day for six days in the week when sufficient ore is available. Now that the cyanide treatment of the concentrates and tailings has been successfully introduced, it is hoped that about 90 per cent. of the gold will be extracted. As the large mass of reserve ore in sight is estimated to contain on the average 1 oz. 2 dwt. 17 gr. of gold per ton, it is looked upon as likely that at least 1 ounce per ton will be actually won. The vein appears to be increasing in width and also in richness as depth is attained. About 60 men were at work at the mine, and development was being rapidly pushed at the close of the year. Frost did not in any way interfere with the operations.

Advantages of the region.

Lieut.-Gen. Wilkinson, chairman of the company, who kindly furnishes the foregoing particulars, sums up the advantages of the Regina mine as follows: "The climate is the most invigorating and healthy in the world. The water is of course unlimited in quantity, and is sweet and soft, leaving no crust in the boilers. It is 15 feet deep close up to the mill wharf, allowing the largest lake steamers to come alongside. Fuel is excellent, close to the mill, very cheap, and inexhaustible in quantity. Mine timber of all sorts is also excellent, close at hand, and very cheap, being only of cordwood value. Communication with the Canadian Pacific Railway is rapid, easy and

inexpensive. Labor is good, chiefly from the Sudbury (nickel-mining) district, and not expensive. Food is abundant, excellent and very cheap ; the largest flour mill in Canada is on the banks of this lake at Keewatin. Powder good and cheap. Steel, iron, lime, cyanide, zinc, tools, and mining supplies of all sorts are to be had at reasonable rates delivered at the wharf at Rat Portage, four and a half hours from the mine." Leaving out of view the statements as to distance from C.P.R., etc., which refer to this property only, General Wilkinson's remarks apply to the western gold mining district of Ontario as a whole, and very aptly set forth the particulars in which comparison can safely be invited with any other region or country in the world.

The immense supply of water which nature has provided in the Lake of the Woods district is of very great importance to the mining industry, which indeed could scarcely be prosecuted without it. The power produced by the falls at Keewatin has already been partially made use of in operating the machinery of the large flour mill owned by the Lake of the Woods Milling Company, and in other ways, and it is now proposed by the Ottawa Gold Milling and Mining Company, Limited, to turn this power to advantage in the stamping of gold ore. This is a concern composed mostly of Ottawa capitalists, Mr. John Mather, president of the Keewatin Power Company, being the managing director. Its capital is $1,000,000 in shares of a par value of $1 each. The purpose of the company is to build a mill of not less than fifty stamps for the purpose of treating ore from the many properties in and around Lake of the Woods upon which stamp mills may not have been erected. By placing at the disposal of mine-owners of small means a thoroughly equipped mill and skilled management, the company hopes in return for a reasonable charge to save such owners the expense of putting up mills on their properties and to enable them to reap a return from their ore from the very outset. The company also proposes to equip and maintain a complete system of barges to carry the ore from the mines to the works, and siding facilities will be provided to receive ore from points east and west of Keewatin contiguous to the C. P. R. The mill and plant are to be under the charge of Mr. F. T. Snyder, a metallurgical engineer of experience from Colorado. Economy is expected to be achieved in the following points, the saving being divided between the milling company and the mine owner : (1) Expense of fuel. The ample water power, constant and cheap, will take the place of wood or coal for generating steam. (2) Outlay of capital. One large mill, with every appliance for doing good work, will be substituted for a number of small mills, probably of inferior equipment. (3) Cost of superintendence. By concentrating the work to be done at a central point, skilled management and superintendence can be supplied which would weigh heavily upon individual operators if provided by each. (4) Special treatment of ores. The gold ore of the district is for the most part free milling, but the company intends putting in processes for treating various kinds of ore, thus enabling a mine-owner to determine which process is the one best suited to the requirements of his property. Ottawa Gold Milling Company.

The Sawbill gold mine is situated on mining location 313X, which along with 314X is owned by the Sawbill Lake Gold Mining Company, Limited, Sawbill mine.

the secretary-treasurer of which is Mr. H. N. Kittson of Hamilton. There are three veins on the property besides the main lode operated. Work was begun in April, 1895, and at the end of 1896 the main shaft had been sunk 145 feet deep. At 60 feet a level was drifted south along the vein 70 feet and north 66 feet; and at 120 feet a second level was run south 25 feet and north 20 feet. Twenty-five men were employed on the average throughout the year, and the total wages paid for labor was $15,000. The machinery consisted of a double cylinder 25 h. p. hoist, and other necessary appliances for sinking the shaft to a depth of 300 feet. The company propose to erect a 10-stamp mill during 1897.

Hawk Bay mine.

The Hawk Bay Gold Mining Company, Limited, of Hamilton and Port Arthur, is owner of the Hawk Bay gold mine, situated on mining location location 324X. Three veins occur on the property. Operations were commenced on 15th October, 1896, and a shaft 7 feet by 10 was put down 60 feet by the end of the year, fifteen men being kept at work. A hoist and boiler of sufficient capacity to sink a shaft to a depth of 300 feet, and a 3-drill air compressor were on the ground, and the erection of a stamp mill was contemplated.

Golden Fissure mine.

Mr. J. T. Sill of New York is proprietor of the Golden Fissure mine, named by the surveyor mining location 5RM. A shaft 7 by 10 feet has been put down 20 feet on the vein, the work being carried on by means of a small hoist. Work had only got under way by the end of the year, having begun on 15th December. Ten workmen have been employed.

Hammond Reef mine.

The Hammond Reef Gold Mining Company owns part of the immense band which was discovered by Mr. James Hammond in the neighborhood of Sawbill lake. Its property is described as mining location 337X. On it eight veins in all are found, on some of which operations have been carried on since August, 1895. Fourteen openings consisting of shafts, drifts and crosscuts had been made at the end of the year. Of the drifts and open cuts one was 150 feet long, three 60, one 40, one 20, one 15 and one 10. From ten to thirty men were kept at work, and about $6,000 paid in wages for labor during the year. About $16,000 in all had been paid out as wages for development work since operations first began. It was contemplated to erect a ten-stamp mill upon the property during 1897.

Kabaskong mine.

The Kabaskong Gold Mining Company, Limited, began in December, 1896, to develop a property known as the south half of mining location 361X, upon which two veins are found. Four test pits have been made, one crosscut run and a quantity of stripping done. Eight men were employed and about $250 paid out in wages.

Wampum mine.

The Wampum Gold Mining Company began work on its location, 361X in January, 1897. A shaft 10 feet in depth has been sunk on one of the three veins, and ten men were prosecuting the work.

Foley mine.

The Foley mine stands in the same prominent relation to the Shoal Lake (Seine river) region as the Sultana mine does to the northern portion of Lake of the Woods, or the Mikado to Shoal Lake (west). It was one of the first to undergo actual development there, and at the close of 1896 not only had a large

amount of exploration work been done and a considerable quantity of ore brought to the surface, but a well equipped 20-stamp mill had been taken in in the face of formidable difficulties of transporation, and put in position ready to begin the extraction of bullion. The mine, which is situated on mining locations AL74, 75 and 76, is the property of the Foley Gold Mines Company of Ontario, Limited, the head office being at 103 Bay Street, Toronto. Mr. J. C. Foley is the resident manager, his address being Seine River, Ont., or Harding, P.O., Minnesota. A large number of veins have been found in the altered granite or protogine, which is the characteristic formation of this section of the district. Up to the end of the year no less than sixteen had been located and numbered or named. One of these, called the West vein, outcrops on all three locations, while the Jumbo and Bonanza veins are found on both AL74 and 75. No. 3 can be traced on AL75 and 76. Most of the exploratory work has been done on locations 74 and 75, little having as yet been attempted on 76. Operations were begun on 75 in March and on 74 in June, 1895. On the West vein seven crosscuts and one test pit five feet deep have been made, showing the vein to have a width of five inches to five feet on an outcropping of over 1,000 feet on AL74. Two crosscuts have been made on the outcrop of this vein on AL75 where it is traceable for 150 feet, and one test pit has been sunk on its extension on AL76. The Jumbo vein shows an outcropping of over 1,000 feet, and a width of 36 to 70 inches as exposed by five crosscuts. A crosscut 107 feet long from the shaft on the Bonanza to the Jumbo vein has been made at a depth of 160 feet, the latter being 5 feet 7 inches wide at that point. The principal workings have been done on the Bonanza vein, on which two shafts have been sunk of the dimensions of 8 feet by 6. The north shaft is situated on AL74, and the No. 5 shaft on AL 75. It had not however been absolutely determined at the close of 1896 whether No. 5 shaft was on the Bonanza vein. The former at the close of 1896 had reached a depth of 210 feet, and the following drifts have been run, whose extent at the same date were as here given: At 100-foot level, south drift 62 feet, north drift 38 feet; 150-foot level, south drift 166 feet, north drift 63 feet 3 inches; 200-foot level, south drift 85 feet, north drift 77 feet. The following winzes had been begun: No. 1, 100-foot south drift, about 60 feet from shaft, 38 feet 3 inches; No. 4, 150-foot, north drift 60 feet from shaft, 19 feet 5 inches; and No. 3, 150 foot, south drift 60 feet from shaft, 18 feet 5 inches. Shaft No. 5, supposed to be on the Bonanza vein, is 1,200 feet south of the north shaft, and drifts have been run therefrom as follows: 60-foot level, south drift 83 feet 2 inches, north drift 47 feet 6 inches. On No. 7 vein two crosscuts have been made showing the vein, which outcrops for over 400 feet, to be 30 inches wide. A test shaft has been sunk 31 feet deep on No. 9 or Concentrating vein, proving it to have a width of 3 feet. On the Double Plate vein, which is 10 to 12 inches wide, a small crosscut has been made and a test pit sunk. Crosscuts have been run on No. 2, Gilt Edge and Humming-bird veins, showing the two former to have a width of 8 to 11 inches each, and the last a width of 15 inches. Test pits have been sunk on the No. 1 or Daisy vein to a depth of 14 feet and on No. 4 to a depth of 10 feet, the latter vein being 20 inches wide. On the Lucky Joe vein a shaft

Extent of the workings.

8 feet by 6 had been put down 39 feet 8 inches, and drifts had been started to the north and south, measuring 13 feet 8 inches and 16 feet 7 inches respectively, showing the vein to have an average width of 16 inches. On No. 3 vein a test pit 19 feet deep had been sunk. During the year from 50 to 75 men were kept at work and about $40,000 paid out in wages to miners, surface help, carpenters, etc. The total amount paid for wages on these locations up to the end of 1896 was $65,000. A complete Fraser and Chalmers 20-stamp mill of the most modern type was on the property, and ready to begin work at the beginning of 1897, equipped with four Frue vanners and all necessary appliances. At No. 5 shaft there is a double drum hoist and boiler; and at the north shaft three Ingersoll rock drills with air compressor and boiler, double drum hoist, self-dumping skip and skip road, and 4,000 feet of gravity tram road with steel rails. A dock has been built at the edge of Shoal lake, with derrick, etc. The buildings comprise office, assay office, boarding house, stable, barn, powder house, blacksmith shop, storehouse, etc.

Ferguson mine.

The Ferguson mine is another property upon which a good deal of development work has been done. It is situated on mining locations AL110, AL111, and K223 and is owned by the Seine River Gold Mines, Limited, an English company of which Mr. T. Nenty Varty is the general manager. Eight veins are found on the property, which have a west-northwest and east-southeast course. Work was begun on 17th October, 1895, and up to the end of 1896 about 3,000 feet of stripping had been done, and test pits of a total depth of 45 feet sunk. Five shafts have been put down, three of them 9 feet by 6, and two 10 feet by 5. No. 1 had a depth of 125 feet, No. 2, 51 feet, No. 3, 87 feet, No. 4, 62 feet, and No. 5, 73 feet. One level was run in No. 1 shaft, east 60 feet and west 70 feet; one in No 3, east 60 feet and west 36 feet; one in No. 5, east 20 feet; and one in No. 4, east 10 feet and west 10 feet. The levels were of the uniform dimension of 6 by 4 feet. Fifty men were employed throughout the year, and $19,000 in wages paid out. About $30,000 had been expended in wages for development and mining work since operations began on the property. The machinery consisted of two single hoists and boilers, and one three-stamp mill.

Empress mine.

The Empress mine, on R569, is owned by the Empress Gold Mines Company of Fort William, of which Mr. J. T. Horne is manager. There are four veins running a little north of east, and work was begun on the property in January, 1896. Three test shafts had been sunk respectively 26, 15 and 10 feet deep, and two adit levels run, one 215 and the other 90 feet in length. The estimated amount of stoping was 29,000 cubic feet. On an average about 28 men per month were at work, the total expenditure for wages and plant being $12,000. There is a ten-stamp mill on the property, and a seven-drill air compressor.

Eagle Nest mine.

The Eagle Nest mine is situated on locations WD25 and WD40, and is owned by the Eagle Nest Gold Mining Company, Limited, of which Mr. J. Van Sommer, 33 Canada Life Building, Toronto, is secretary. There are 16 veins running northwest and southeast and one lateral vein on the property. Work was begun in 1892, and continued in 1895 and 1896. C vein has been

stripped 40 feet, D vein 131 feet, E vein 140 feet, F vein 204 feet, and H vein 50 feet. Ten test pits from 6 to 8 feet deep have been sunk on the last four mentioned veins. On the lateral vein, named XXX, five large pits have been sunk from 6 to 10 feet deep, and from 8 to 25 feet long. Twelve workmen were employed and $556.50 paid out in wages in 1896. The total expenditure upon the property up to the end of 1896, has been about $1,750.

The Crystal Gold Mining Company of Rathbun, Limited, of which Mr. W. R. White, Q.C., Pembroke, is secretary-treasurer, is the owner of the Crystal mine, or mining location WD44, situated in the township of Rathbun Nipissing district. Two veins run east and west and five shafts in all have been sunk. No. 1 shaft was sunk a depth of 100 feet, cutting a vein at 85 feet which was followed several feet on both sides of the shaft and proved to be rich in free gold. At the 100 foot level a lateral drift was made and the vein again picked up at a distance of 25 feet from the main shaft. No 2 shaft was sunk a distance of 40 feet and showed the vein to improve in size and quality of ore. No. 3 shaft or tunnel was driven on a vein showing at the base of the hill on which No. 1 shaft is sunk to a distance of 50 feet, and lateral drifts of 25 feet on each side have been made therefrom. No. 4 shaft is sunk on a vein outcropping about 500 feet from any of the other openings, and is down about 24 feet with about 15 feet of drifts. At the base of the hill near No. 3 opening a vein about 2 feet wide has been uncovered for a distance of 55 feet, and the exposed quartz is thickly studded with free gold. About ten men have been employed on an average during the year, and $5,000 paid out in wages for labor. About $10,000 for development and mining work has been expended on the location from first to last. There was no machinery upon the ground at the close of the year, but the company were arranging to put up a five-stamp mill with sufficient power to run ten stamps. Crystal mine

On lots 12 and 13 in the fourth concession of the township of Kelly, in the district of Nipissing, is situated the Gold Cliff mine, owned by a Toronto syndicate, of which Mr. John Galt, C. E. and M. E., is interim managing director. A hill rises abruptly from the south shore of Upper Koo-ka-ga ming lake, and forms a steep inclined cliff composed of Huronian slate reaching to a height of about 200 feet. The formation is in contact with a diorite protrusion which is clearly defined on the top of the hill and runs in a continuous and regular direction. Eight veins up to fifteen inches wide are found on the property running nearly east and west. Six of these have been stripped along the face of the cliff at intervals for about 2,000 feet. Work was begun in 1895 and an open cutting has been made and a tunnel begun at the foot of the cliff, the object being to inters ct the veins and reach the diorite wall or dike. It was hoped that this tunnel would prove that the veins, which were somewhat irregular and shattered at the surface, would develop into a true contact vein of large dimensions as they approached the diorite. The estimated cost of the tunnel was $1,600. Three to seven men have been employed during 1896, and about $1,000 paid out for labor. About $2,000 has been expended in wages for development and mining work since the beginning of operations on this property. Gold Cliff mine.

Ledyard mine.

At the Ledyard mine, east half lot 19 in the first concession of Belmont township, Peterboro' county, development work was resumed in December, 1896, with a force of about 20 men. The following particulars represent the condition of affairs on 14th April, 1897 : Shaft No. 1 had been sunk to a depth of 100 feet under the direction of Mr. Brooks. The vein continued to be well mineralized with iron sulphurets carrying gold. A crosscut of 85 feet showed the vein to be 18 feet wide. Several assays of ore taken from the bottom of the shaft gave an average value of $12 per ton in gold. Mr. Wm. Nichol with five men has been prospecting and opening up new veins on the property. About 100 yards west of the Burnt Knoll a pit was sunk on a large vein which panned gold freely. After considerable preliminary work it is believed that a vein has been located on the south side of the Burnt Knoll, where it is proposed to sink a shaft. Near the railway track about 300 yards west of the Burnt Knoll a good sized quartz vein has been discovered, showing free gold with sulphurets uniformly distributed through the ore. This has been called Clark vein, and being situated on the slope of a hill presents good facilities for cheap mining. At the Nichol vein overlooking the railway there is a large outcropping of ore apparently on a north and south vein. The ore is well mineralized with iron and copper sulphurets, the average of six assays giving $23 per ton. A good boarding house, dwelling house and new stable have recently been erected on the property. The Ontario, Belmont and Northern railway which has been completed into the Belmont iron mine runs through the Ledyard gold mines property, passing through the village of Marmora and connecting with the Central Ontario Railway and the C. P. R.

Deloro mine

The company that is operating the mine at Deloro formerly operated by the Canada Consolidated Gold Mining Company is the Canadian Goldfields, Limited, incorporated in London, Eng., under the Companies' Acts on 16th June, 1896, with a capital of £400,000, the agents and promoters of the company being the firm of Matheson & Co., of London. Application was made during the fall of 1896 for letters patent under the Ontario Joint Stock Companies' Act, which were granted on the 24th day of December, 1896.

The company which originally interested itself in the property at Deloro and in other properties throughout the county of Hastings was the Canada Venture Syndicate, Limited, also incorporated in London under the English Companies' Acts, which had acquired certain options and rights at Deloro besides several thousand acres principally in the township of Marmora. These rights have in part been transferred to the Canadian Goldfields, Limited, although the Canada Venture Syndicate still retains some 10,000 acres of land which it proposes to develop. The Syndicate also succeeded in making arrangements with the Gold Ore Treatment Company, Limited, of London for the Canadian rights of the bromo-cyanide process for the treatment of gold ores—sometimes called the Sulman-Teed process, from the names of the inventors—which has a special aptitude for extracting gold from arsenical and other refractory ores by means of solution ; but in disposing of the Deloro mine and other properties the Syndicate also transferred to the Canadian

-oldfields, Limited, the rights to use upon them the bromo-cyanide process.[1]

The operations of the Canadian Goldfields, Limited, have been mainly cen -ed upon the property at Deloro, although it has also been developing quietly number of other properties in respect of which good results have been btained. The Deloro property consists of about 500 acres. Practical opera- ons were commenced at the mine during the early fall of 1896, and have een continuously carried on since that time. Owing to the desirability of cquiring a central property for a mill site which the company could control, nd which would lay under tribute a large number of other properties upon hich it had options, a mill site of 40 acres was purchased from one 'Connor immediately adjoining Marmora station on the Central Ontario ailway. On this property extensive works were commenced in the fall of ist year, and completed in March of this year, which are equipped with mills r pulping the ore, vats for leaching the pulp by means of the bromo-cyanide lution, and tanks for precipitation of the gold-bearing liquors. The com- any, it may be said, holds options upon 25,000 acres apart from the lands cquired from the Syndicate; and its actual cash expenditure for lands, build- ngs, machinery and mining work already approaches $100,000.

Geological features of the Deloro mine.

The following brief description of the geological features presented by the Deloro property, and of the workings of the mine, is by Dr. A. P. Coleman, ineralogist of the Bureau: "The once famous Deloro mine lies, according Mr. E. Coste's map as published by the Geological Survey, at the disturbed oundary between Archæan rocks and eruptive granite, the latter sending rms into the Archæan and enclosing fragments of it. So far as could be en on March 26th, 1897, when the mine was visited by Mr. Blue and my- elf, the Archæan where showing through the snow is a dark green altered iabase, very like the Huronian diabases of western Ontario. The granitic ock penetrating it is partly a pale flesh colored binary granite containing ttle or no mica, partly a dark syenite consisting of orthoclase, plagioclase and ornblende with a little quartz.

[1] In the Sulman-Teed process the solution may consist, in addition to an ordinary cyan- de solution, of a small proportion of one of the haloid compounds of cyanogen, viz., either e chloride, bromide or iodide. The chloride being gaseous at ordinary temperatures, its nployment is barred on account of difficulty of transport; while the iodide, though a pow- rful solvent in combination with potassium cyanide, is too expensive for use. The bromide, white, crystalline, salt-like compound, is solid within all ordinary ranges of air tempera- ire, and in the form in which it is supplied may be preserved unaltered for indefinite periods hen stored in well-closed vessels; and as bromine may be purchased in quantity for about 5 cents per pound, it is claimed for bromide of cyanogen that it is a cheap, practical, sol- ent reagent, capable of easy production, transport and application. When the ore is milled a 30 or 40 mesh fineness the dissolving agent acts readily upon it in the vat; but in the case f a compact ore in which the gold is very finely disseminated, crushing to a 60 or even an 80 esh fineness may be necessary. The bromo-cyanide process is far quicker in its solvent ction on fine gold than is the ordinary cyanide method, and this is its chief merit. The me of leaching will vary according to the grade to which the ore has been crushed, the fine- ess of the gold, etc.; in some cases less than eight hours has been sufficient for perfect xtraction, while in others twenty-four hours and even thirty-six hours are necessary. Each re requires treatment entirely upon its own merits and according to its special requirements, nd therefore the success of the bromo-cyanogen process will be found to depend largely on e skill and intelligence of the mill manager.

"The material disclosed by mining operations and thrown upon the dump is a schistose looking gneissoid grayish rock, or a paler gray sericite schist. In the mine itself a specimen of country rock taken from the end of a crosscut driven 43½ feet west on the second level appears to be fine grained gray quartz diorite; a specimen from the end of a crosscut reaching 38 feet to the east on the first level is coarse grained dark green diorite.

"It is an interesting point in the geology of the region to find greatly crumpled pale gray calc schists a little to the west of the mine, belonging no doubt to the Hastings series. Irregular areas of Cambro-silurian limestone overlie the Archæan.

"There is no sharply defined vein to be seen, but a very irregular shattering of the country rock has given space for the deposit of quartz, a little calcite and other carbonates, a varying quantity of arseno-pyrite (mispickel) and a little iron and copper pyrites. Free gold shows itself occasionally, but not in large nuggets, and generally in the quartz. It is observed that a mixture of fine grained arsenical pyrites with quartz gives the highest gold contents when assayed. Solid, coarsely crystalline arsenical pyrites is poor in gold, and quartz free from sulphides still poorer.

"While it is true that a distinct vein can scarcely be traced, the general band of ore-bearing shattered rock can be followed a long way north and south; and there are points, e. g., toward the south end of the workings, where a well defined foot wall may be traced some distance. In most parts of the mine however the quartz comes in quite irregularly, varying in width and in dip. It averages perhaps five feet in width, running from less than a foot to a cross section twenty-five feet wide, in the last case including some rock. The dip of the deposit is from 50° to 60° towards the west.

"The mine as at present worked includes two former mines, the Gatling mine to the north and the Tuttle mine to the south. The main shafts of these two mines are 420 feet apart. There are also two other shafts, the Timber shaft, 66 feet north of the Gatling, and one 300 feet south of it. The shafts follow the dip of the ore deposit, and the Gatling shaft, which is the deepest, reaches a vertical depth of 95 feet. Over a thousand feet of drifting have been done on three levels. On the upper level a drift runs 290 feet south from the Gatling shaft, having been recently extended so as to connect with the corresponding level of the Tuttle mine.

"The present company began its work about the middle of September, 1896, but a great deal had to be done in pumping out the mine, timbering portions of it and putting things generally in order; so that real mining did not commence till the latter part of November. At present it is thought that the work has so far advanced as to provide plenty of ore to keep the mill running. In general, drilling is done by hand, but the Tuttle shaft is being sunk with steam drills. Seventy men are employed at the mine above and below ground under the supervision of Mr. P. Kirkegaard as mine manager and Mr. A. J. G. Swinney general superintendent of the mine and reduction plant.

"The two large brick houses built by the former owners years ago have

·en refitted and are occupied as offices, etc. ; but the huge mill building with s roasting furnaces and chlorination plant stands idle.

"The mine is evidently managed in an efficient, businesslike way, and the ork done proves the existence of a considerable body of ore ; though the very regular character of the deposit makes its continuance less certain than it ould be in the case of a well defined fissure vein on which the same amount ' development had been done."

CORUNDUM.

Discovery of a corundum deposit in Hastings county.

Under date of 23rd October, 1896, Dr. George M. Dawson, Director of ie Geological Survey at Ottawa, communicated to the Bureau the discovery ' corundum in the township of Carlow, in Hastings county. This discovery as made by Mr. W. F. Ferrier, of the Geological Survey, who made an camination of the deposit and wrote a preliminary report upon it which Dr. ·awson has placed at the disposal of this Bureau for publication. It is as ·llows :

FERRIER'S REPORT ON THE DISCOVERY.

Report by W. F. Ferrier to the Director of the Geological Survey.

"One of the most interesting occurrences upon which I have to report is ie recent discovery of corundum in Hastings county, Ontario. This came bout in a somewhat unusual way. In 1893 I came into possession, by pur-iase, of a number of specimens collected by Mr. John Stewart, formerly of ·ttawa, amongst them being a package labelled 'Pyroxene crystals, south art of Carlow.' On examining these specimens some time ago I recognized iem as corundum, and immediately took steps to ascertain, if possible, the recise locality from which they came. As you are aware, I communicated he facts to you, and was authorized in October to visit the township of Car-·w with the object of endeavoring to locate the mineral and determine the xtent of the deposit. I was accompanied by Mr. Cole, and after considerable ifficulty found the mineral on the 14th lot of the 14th concession of the ownship of Carlow, Hastings county, Ontario. It was there found to occur i a coarse grained red, felspathic rock, having the appearance of a pegmatite. Iicroscopic sections are in course of preparation, and the precise nature of he rock will then be fully determined. The difficulty of preparing sections onsequent upon the hardness of the contained corundum has rendered it mpossible to make the examination in time for this report. This rock, to-ether with a red and brown micaceous gneiss, forms a perpendicular cliff from 0 to 100 feet high, at the base of a sloping mountain. The corundum-bearing o·k runs into the gneiss side of the mountain along the strike, as well as ccurring, as already stated, on the face of a cliff across the strike. Well eveloped crystals, often of large size, and generally of a grayish or brownish olor, as well as irregular masses of the corundum, are thickly listributed through the rock, and the mineral was observed hroughout this rock for a distance of about 300 feet across the strike, and traced long the strike more or less continuously for about 700 feet. The grain of he mineral varies with that of the rock. The quantity is not uniform hroughout the mass, portions of the rock being more thickly studded with

Occurrence of the corundum in Carlow.

the crystals than others, and in places they seem to form 'stringers' in the rock. The interest of the find lies not so much in the possibility of the discovery of the gem varieties of the mineral, ruby and sapphire, about which so much has lately been said in the press, and which is improbable in view of the mode of occurrence, but in the fact that this is the first time that the mineral has been found to exist in Canada in any quantity, and that it is valuable as an abrasive material on account of its great hardness, which is in a pure mineral next to that of the diamond.

A reported occurrence in Burgess.

"In the Geology of Canada (1863, p. 499) mention is made of corundum in the following words :—'Corundum has been observed on the second lot of the ninth range of Burgess, and in the immediate vicinity of a deposit of copper pyrites. Here, in contact with the crystalline limestone, occurs a rock made up of felspar, quartz, calcite, silver, white mica and sphene. Disseminated throughout this aggregate were small grains of a mineral whose color varied from light rose red to sapphire blue, while its hardness, which was greater than that of topaz, showed the mineral to be corundum. Small crystals of light blue corundum have been found elsewhere in the limestone of the vicinity.' No specimens of this occurrence have found their way into the collections of the Survey, and I have not met with any one who has seen the mineral from this place. It is the only locality cited for Canada in the exhaustive monograph on American corundum by Francis P. King,[1] the information being furnished by Dr. F. D. Adams.

Characters of the mineral.

"Corundum is an oxide of aluminium, the crystallized varieties being essentially pure, whilst the granular variety, to which the name 'emery' is given, contains more or less impurities, chiefly magnetite and hematite. The transparent purer kinds of red and blue colors constitute the gems ruby and sapphire. These usually occur as rolled pebbles in river beds, or as crystals embedded in various rocks, such as limestone, as in the famous ruby mines of Burmah.

"Statistics show that as an abrasive material there is an extensive market for the corundum. The supply of the mineral in the United States comes chiefly from North Carolina and Georgia, small quantities of emery being also obtained in Westchester county, New York State. The finer grades of emery continue to be imported from Turkey and Greece.

Method of treatment.

"Since the present discovery was announced by the Geological Survey numerous enquiries have been received regarding it, and samples have been furnished to interested parties. Some of these have been tested in the United States, and the corundum pronounced to be of the finest quality. It may be well here, I think, to allude to the proper preparation of the material, essential to its introduction for commercial purposes. It is necessary that it should be completely freed from the gangue, and this can only be accomplished by a special process. The corundum-bearing rock is first crushed, and then washed by means of sluice-boxes or revolving barrel-shaped cylinders, through which a stream of water passes. But this is not all, for if the fragments of corundum be examined it will be found that a large proportion of them are

[1] A Preliminary Report on the Corundum Deposits of Georgia, by Francis P. King, Assistant Geologist. Bull. No. 2, Geol. Survey, Georgia, 1894.

coated with a micaceous mineral, having in many instances the composition of margarite, and resulting from the alteration of the corundum. This is removed by passing the mineral through another machine which, in a form used at one of the principal Georgia mines, contains two discs armed with points which are revolved with great rapidity, and soon wear away the soft coating. After undergoing this process the mineral is again washed, crushed and sifted to the various degrees of fineness required. Great care is necessary to prevent its reduction to 'flour," as this has only a small value compared to that of the coarser grades. The purpose of all the manipulation it undergoes is to secure uniformity of hardness in the finished material.

" Pending further investigation, the lands (which belong to the Crown) on which the corundum occurs in Carlow, have been withdrawn from sale by the Ontario Government, and it is hoped that the deposit will prove as valuable as the surface conditions seem to indicate. It is more than likely that this is not an isolated occurence, but that other deposits will be found in the Hastings district, now that attention has been called to it. The very circumstances attending the present discovery show that the mineral is liable to be passed over or mistaken for something else."

FURTHER INVESTIGATIONS.

Under instructions of the Commissioner of Crown Lands a quantity of the mineral was taken out of the Carlow deposit and shipped to the works of the Hart Emery Wheel Company at Hamilton, where a test was made of it; but the quantity treated was not sufficient for a satisfactory determination of its value. The report however was quite favorable regarding the abrasive qualities of the mineral.

Practical test at the Hamilton Emery Works.

Numerous samples were distributed by the Bureau to mineral collectors in the Province, as well as to prospectors, and there is reason to believe that corundum occurs over a wide area in the eastern counties. An interesting discovery was made by Mr. George Bennett at a mica mine in the township of Methuen, samples of which have been examined by several experts. George F. Kunz of New York city describes it as in part of an excellent blue color, although not of sapphire value, but of abrasive value equal to any that he has seen from South Carolina, Georgia or elsewhere. Dr. Coleman also made an examination of corundum and another curious mineral from the same location, and in a report upon them says: " The two specimens of corundum are of better appearance than those previously found in Ontario, lacking the soft, decomposed surface seen on former ones. They are also more translucent, and one of them approaches sapphire, having at some points an ultramarine blue color. The corundum is associated with a little muscovite. Both specimens show one well-marked cleavage, no doubt basal, and three less perfect cleavages corresponding to the planes of the chief rhombohedron. The main cleavage faces are striated in three directions, forming equilateral triangles in accordance with the less perfect rhombohedral cleavages. The blue specimen comes nearer to gem quality than any other specimen from Ontario which I

Corundum in Methuen township.

have examined. . . An example of white rock, resembling crystalline limestone in appearance, comes from the same general region. The white mineral proves, on examination with the microscope, to consist mainly of plagioclase felspar with a little orthoclase and muscovite. In it are embedded crystals of magnetite, and also portions of a mineral having one perfect cleavage with a bronze lustre. This mineral scratches topaz and gives a blue color with cobalt solution, indicating alumina, so that it is probably corundum. It is however very different in appearance from typical corundum. It is very desirable that a larger quantity of the mineral should be provided, so that a complete analysis may be made in order to settle its character."

EXPLORATION OF THE CARLOW REGION.

Tracing up the extent of the Carlow deposit.

As corundum is a substance of considerable commercial importance, it seemed advisable that a detailed examination of the deposits in the Carlow region should be made in order to gain an idea of the quantity of the mineral present, and it was thought that by careful prospecting other deposits of the mineral might be found in the district. Further, it was thought that a study of the character of the deposits and their relations to the inclosing rocks should be made with the view of giving information to prospectors, and thus enabling them to search more intelligently for the mineral. Accordingly instructions were given to Mr. W. G. Miller, of the Kingston School of Mining, to undertake an examination of the deposits and to search for other occurrences of the mineral, and he is at the present time engaged in carrying out this work.

The corundum-bearing rocks have been traced by Mr. Miller in a north-easterly direction through the northern part of the township of Carlow into the 18th and 19th concessions of Raglan, thence across the York Branch and Madawaska rivers to the south half of the 28th lot in the 19th concession of Raglan.

As it is a number of years since the surveys of these townships were made, and the country has since then been in part burned over, it is often difficult to determine the boundaries of the lots and concessions, but it may be said that the mineral in the township of Carlow occurs in the 13th, 14th, 15th and 16th concessions east of lot 14 in each. Time has not yet permitted of an examination of the rocks in the northwest part of this township.

The mineral is also found on a number of the lots in the 18th and 19th concessions of the township of Raglan west of the York Branch, a tributary of the Madawaska. It has been found, too, on some of the lots in the 17th, 18th and 19th concessions of Raglan, between these rivers, and on a number of the lots in the 18th and 19th concessions to the east of the Madawaska river.

Mr. Miller's work has thus far enabled him to connect the previously known deposits of the two townships by means of others which occur in line with them and to trace the corundum-bearing rocks across country for a dis-

Sawbill Mine. View of the camp.

Office at Ferguson Gold Mine.

Junction of Keewatin Schist (dark) and Granite (light) on Island Bay, Bad Vermilion Lake.

The Shore at Andrew Bay, Lake of the Woods.

tance of about eleven miles. This band of rocks has been found to have a breadth in its western part of about $2\frac{1}{2}$ miles. In the eastern part its breadth so far as worked out is about one mile. It is his intention to try to trace the band farther west in Carlow and farther east in Raglan.

Outcroppings connected over Carlow and Raglan, for a length of eleven miles.

The band of corundum-bearing rocks, starting from lot 14 in the 14th concession of Carlow, has as its more central part a ridge of high hills which at first, along its northern face, trends to the northeast, but in passing through the eastern lots of the north of Carlow the ridge takes on a more easterly course and follows pretty closely the direction of the line between concessions 18 and 19 of Raglan through the western part of this township, thence across the York Branch and Madawaska rivers, so far as traced, to the southern part of lot 28 in the 19th concession of Raglan. There is a break in the ridge at lot 14 in the 14th concession of Carlow and also near lot 28 in the 19th concession of Raglan. West of lot 14 in Carlow and east of lot 28 in Raglan no corundum has been found, although the mineral has been observed on both sides of the line connecting these lots with each other and at some distance from it.

Modes of occurrence.

Mr. Ferrier in his description of the mode of occurrence of the corundum on lot 14 in the 14th concession of Carlow says: "It was there found to occur in a coarse grained, red, felspathic rock having the appearance of a pegmatite." He also states that this rock runs into a red and brown micaceous gneiss along the strike, as well as occurring on the face of a cliff across the strike. This description will serve in a general way for the mode of occurrence of most of the corundum in the townships of Carlow and Raglan. The mineral has also been found near the northwest corner of Raglan in the interesting and comparatively rare rock, nepheline syenite, a mode of occurrence which it is believed has not been observed in any other part of the world. This rare rock is known to occur in other townships of this district to the southwest of the township of Raglan.

The gneiss throughout the belt of corundum bearing rocks is cut through by a series of characteristic coarse-grained dikes in which red or light colored felspar is an essential and abundant constituent. In some of these dikes corundum is found, while in others the mineral is absent. In the corundum-bearing dikes quartz is absent, or sparingly present, while in the dikes in which corundum is not present quartz occurs usually in considerable quantity. These two kinds of dikes, so far as their felspathic constituent and grain are concerned, and their field relations, are much alike. They may both be spoken of as pegmatites. Dikes of the one kind have been observed cutting or fusing into those of the other, but in cases examined it could not be decided that they were different in age.

No microscopic or other laboratory examination has been made of specimens collected in the field by Mr. Miller, nor has an attempt been made as yet to determine carefully the field relations of the rocks with which the corundum is associated. His time up to the present has been occupied almost

entirely in trying to determine over how great an extent of territory the corundum occurs. It would not be well before more work has been done on the deposits to make more than a general statement concerning their economic value. Mr. Ferrier says of the occurrence of the mineral in Carlow that "it is hoped the deposit will prove as valuable as the surface conditions seem to indicate." It may be said that deposits in the townships of Carlow and Raglan to the east of this one have been observed whose extent is as great and in which as high and even higher percentages of the mineral occur.

There are several good water powers situated within easy access of the two deposits, notably at Palmer's Rapids on the Madawaska river and at one or places on the York Branch. There is steamboat communication via the York Branch and Madawaska rivers with Barry's Bay, a station on the Ottawa, Arnprior and Parry Sound Railway. The deposits are also favorably situated as regards labor, supplies and shipping facilities.

In a favorable situation.

The object sought in writing these notes has been to make known the extent of territory over which corundum has been found. A detailed examination of the deposits is now being made by Mr. Miller, and an account of the results arrived at will be published in the next annual report of the Bureau.

Mineral rights withdrawn from sale pending a final report.

Meantime it may be stated that the mineral rights in those lands over which the corundum belt is found to extend have been withdrawn from sale, pending the completion of Mr. Miller's final report.

MINING ACCIDENTS.

Accidents in 1896.

The accidents reported to the Bureau as occurring in the mines of the Province during 1896 were five in number, three of which were of a fatal character. Two of the deaths occurred at the Sultana gold mine within six weeks of each other, and strangely enough from the same cause, namely, falling down the mine shaft. The third took place at the Copper Cliff mine, owned by the Canadian Copper Company, and was due to the falling of a piece of rock from the roof or wall upon an unfortunate miner, who was instantly killed. The circumstances of these several casualties, as well as of those which were not attended with fatal results, are given briefly below.

At the Sultana Mine.

The first accident reported was that by which Axel Carlson, night foreman of the Sultana gold mine, lost his life on 21st April, 1896. It was his practice to descend into the mine ahead of the gang of men of whom he was in charge, and on this occasion when the latter climbed down the ladders at midnight to resume work they found Carlson lying at the bottom of the shaft with his neck broken and quite dead. No one was with him when the accident took place, and there were no witnesses of the occurrence, but it is presumed that by a regrettable slip or mischance he missed his footing at some point in the last thirty feet of the ladderway and was precipitated to

Death of Axel Carlson.

the bottom. Coroner ApJohn of Rat Portage was notified of the accident and went out to the mine. A careful enquiry from the mine employés, many of whom were Swedes and Carlson's fellow-countrymen, and from others, satisfied the coroner that the ladders were in no way defective, and that there was no blame to be attached to the owner of the mine or to those in charge of it for the accident. He therefore did not consider it necessary to hold an inquest. The deceased was thirty-two years of age and was unmarried, his mother still living in Sweden. He bore the reputation of being a sober and industrious man, and enjoyed the respect of his employer and fellow miners. He was certainly a brave man, as his conduct showed in being the first to descend the Sultana shaft and begin the rescue of the almost suffocated miners who were imprisoned by the burning of the shaft house and mine timbers in March, 1895, as narrated in the Bureau's Report for that year, p. 238.

Death of Charles Westman.

On the morning of June 5th a man named Charles Westman, an employé at the Sultana mine, fell down the shaft from the first level and was taken up dead. Coroner ApJohn was informed of the accident, and made a preliminary investigation which led him to the conclusion that Westman's death was due to his own carelessness, and he did not deem an inquest called for. It appeared that the man along with other workmen was on the first level near the shaft, and while the others were removing drills from the bucket which had just been lowered, preparatory to beginning work, he either walked or fell into the shaft, and so met an instant death. There did not appear to be any explanation of Westman's conduct but recklessness or extreme want of care. In view however of the accident happening so soon after the death of Axel Carlson at the same mine and in a somewhat similar way, it was considered by the Bureau advisable that a more formal investigation should be held into the circumstances, and Mr. ApJohn was therefore instructed by the Attorney-General's Department to hold an inquest. Mr. Henry Langford, District Crown Attorney, was at the same time notified to assist in bringing out all the facts. An inquest was held accordingly on 8th June. A jury was sworn in at Rat Portage, which viewed the body and adjourned to the Sultana mine, where the shaft was inspected and the evidence of the men taken who were present at the time the fatality occurred. The verdict of the jury was that Westman met his death through an accident caused by his own carelessness, and that the management of the mine was in no way responsible, the opening of the shaft where the accident occurred being protected by a fence, as required by the Mines Act. (See Part IV., section 69, Rule 8). The verdict was concurred in both by the Coroner and the Crown Attorney. Deceased was about thirty years of age, a native of Sweden, unmarried, and without relations in this country.

At the Evans Mine.

On 8th July, at the Evans mine, owned and worked by the Canadian Copper Company, a man named Percy McNolty, while working near the bottom of an inclined stope, from which ore was being loaded into tram cars,

Injury of Percy McNolty.

was struck by a piece of rock rolling down the stope and catching his leg before he could get out of the way. The result was a fracture of both bones of the left leg. He was removed to the hospital at Sudbury, and on 15th July was reported by Dr. R. B. Struthers as making satisfactory progress towards recovery.

At the Copper Cliff Mine.

In the ninth level of the Copper Cliff mine, the property of the Canadian Copper Company, a drill-runner named James Gilchrist had on 19th October drilled a hole in the stope on which he was working about ten feet deep, in which he placed nine sticks of dynamite. In the top stick he inserted the exploder and was stooping over the hole, when a spark of fire, it is surmised from the miner's lamp which was in his cap, dropped into the hole, which had not been tamped. The spark set fire to the dynamite or some foreign substance in the hole, and when Gilchrist saw this he and his helper at once made an effort to reach a place of safety before the fire could reach the detonator, when an explosion would be inevitable. They succeeded in getting under cover of a step in the stope some ten feet away, but notwithstanding this partial protection the explosion resulted seriously for Gilchrist. His head was badly cut by the flying pieces of rock, his left arm broken above the elbow, two fingers of his left hand mangled, and his right arm dislocated. He was taken to the hospital at Sudbury and properly cared for. On 4th November he was reported as improving as rapidly as could be looked for, and as not being subjected to any intense suffering.

Injury of James Gilchrist.

Death of David McGregor.

The third fatal accident of the year took place on 29th October in the Copper Cliff mine, whereby a drill-runner, David McGregor by name, lost his life. Deceased was engaged on the eighth level, along with five others, after the day shift had left, and during the meal hour from 6 to 7 p.m., doing some work preparatory to the coming of the night shift. While so employed a piece of rock fell upon him without warning, striking him in the back and killing him at once. The company notified the coroner, Dr. McMurchy of North Bay, immediately, and on 31st October that gentleman and Mr. A. G. Browning, District Crown Attorney, were directed by the Attorney-General's Department to conduct an investigation into the manner of McGregor's death. On the same day James McGregor, junior, applied to Coroner McMurchy to have an inquest held, alleging in his affidavit of information that he had reason to believe that the ground overhead where deceased was working when killed was not safe. A jury was accordingly empanelled, Mr. D. Baikie, bookseller, Sudbury, being foreman. Evidence was taken on 3rd November, Mr. James McArthur, general manager of the company, and a number of the miners and foremen being summoned to give evidence both as to the circumstances connected with this particular accident and the precautions taken generally to prevent casualties of a similar nature. There was some doubt as to where the falling piece of rock came from, and the company endeavored to show that it might have fallen through a winze rising from the

eighth level ; but the evidence went to show that the winze was covered with timber, and only very small pieces of stone could fall through this covering, and even then some of the witnesses doubted whether a stone falling through the winze could strike a man on the ledge where McGregor was working. The system of "scaling," or examining the walls and roofs of the mine for loose pieces of rock or ore, in use at the Copper Cliff, was called in question, and it was alleged that this operation was not performed with sufficient regularity or frequency to reduce the danger from this ever-impending source to a minimum. It was shown that the roof of this level was last scaled on 11th October, some eighteen days before the accident took place, when it was examined by Foreman Dan Wink with torches from the top of a fiftysix-foot ladder, the roof being sixty feet above the floor. Testing roofs and walls for loosened material, or to detect the presence of cracks or seams, is frequently done by tapping them with a hammer, the difference in the sound made by a blow upon loose and upon firm rock being readily recognized. The examination made on 11th October showed the roof to be apparently sound, and although it is stated that no mining was done under the roof from 11th to 18th October, yet it is possible that the blasting which was subsequently carried on there from day to day may have loosened some material overhead or widened some hidden seam, with the result of bringing down the piece of rock which killed McGregor. As to the method of scaling in vogue at the mine, Captain H. Davies deposed :

> My orders to the foremen are to do scaling at all times when necessary, and always after every blast. As a rule scaling is done every Monday morning. It would be impossible to scale the mines thoroughly every week, as no other work could be done profitably. The scaling is done whenever it is thought to be most necessary. I do not think that my judgment was at fault in scaling in this case. Even after the most thorough scaling it may happen that a loose rock may fall. My instructions to the men are, never to go on dangerous ground. Ground may be loosened by the concussion of the air from blasting. My opinion is that the rock came from the roof. . . There are numerous seams in the roof on the eighth level in places.

It was shown that more or less water kept falling through the winze to the floor of the eighth level, but in the opinion of Captain Davies "water makes no impression on the nickel ore in these mines, and will not loosen the nickel and copper ore."

The jury were evidently impressed with the view that a certain lack of vigilance was chargeable against the company in connection with the method of scaling employed in the mine, their verdict being as follows :

Verdict of the Coroner's jury.

> We believe that deceased David McGregor's death was caused by being struck by rock or ore falling from the roof of the stope in the eighth level of Copper Cliff mine. We are of opinion that there has not been sufficient inspection and testing of the roof of the mine where blasting is being done, especially where water is coming through the roof or winze, to properly protect the workmen.

The Company did not concur in the finding of the jury, and applied to the Bureau to have the Inspector of Mines visit the mine and examine the eighth level, with the object of ascertaining what amount of care had been exercised by them with the view of preventing such accidents. They stated that since the accident to McGregor a thorough examination of the winze,

roof and walls of the eighth level had been made under the supervision of Foreman John Harris, and the men, after sounding that part of the roof in question, had pronounced themselves perfectly satisfied as to its firmnees and safety, one of them making the remark that he would not be afraid to go to bed and sleep under it. In view however of all the circumstances, and of the known tendency of coroners' juries in such cases to take as lenient a view as the facts will warrant, it was not deemed advisable to interfere in the matter, or to attempt to disturb the finding of the jury. The Inspector's observations on the cccurrence of this accident will be found in his own Report.

SECTION II.

THIRD REPORT ON THE WEST ONTARIO GOLD REGION.

By Dr. A. P. Coleman, Geologist and Mineralogist to the Bureau.

In accordance with the instructions of Mr. Archibald Blue, Director of the Bureau of Mines, the work of examining and reporting upon the gold mining region of Western Ontario, begun in 1894 and carried on during the following season also, was continued during the past summer. Professor Arthur B. Willmott, of McMaster University, was appointed assistant and gave efficient service. Introduction.

We left Toronto on June 27, taking the Canadian Pacific route via Windsor and the upper lakes. After two or three days delay in Fort William and Port Arthur purchasing supplies, getting information and attempting to secure canoemen, a start was made from Savanne on July 4. The men employed were Richard Weigand and H. S. Patterson, the former of Port Arthur, the latter of Savanne. Both proved willing and efficient.

The route followed included the upper Seine region, where the Sawbill and Harold lake mines were visited, and the lower Seine, including the mining camps about Shoal, Bad Vermilion and Little Turtle lakes. Fort Francis was reached on July 23, and the following day we provisioned and set out for the Manitou region. Here the more interesting locations were visited on lake Manitou, as well as the later finds between it and Mud lake. Route taken.

On August 1 we left lake Manitou and followed a chain of lakes westward to Regina bay, an inlet of Whitefish bay, part of the Lake of the Woods. After visiting the Regina mine and other points of interest to the north we arrived at Rat Portage on August 7. Here Richard Weigand was paid off and Thomas McDonald engaged as canoeman. Four days were employed in repairing canoes and obtaining supplies, after which the Sultana mine and others to the east were examined and a trip made to Camp bay near the lower end of Whitefish bay, where interesting gold discoveries had recently been made. We returned to Rat Portage August 25. As Prof. Willmott's eyes had become seriously inflamed, and canoeing seemed to aggravate the trouble, he decided to return to Toronto.

Leaving Rat Portage on August 26 I visited the Mikado mine and adjoining locations on Shoal lake, near the Manitoba boundary, and then various locations in the neighborhood of Rat Portage. After a delay of several days in order to be present as a representative of the Bureau of Mines at a meeting of the Mining Institute of Ontario, held for the first time in Rat Portage, I left that town on September 9.

On the way home some interesting old beaches were visited at and near Port Arthur, Schreiber and other points on the north shore of the upper lakes, and the Empress mine at Jackfish bay was examined ; so that it was September 18 before I reached Toronto

The travel accomplished.

During the summer six hundred and seventy miles of canoe travel were accomplished, and all the working mines as well as a great number of more or less promising prospects in the West Ontario gold field were examined.

A leading featur of the work.

While examining the various properties special attention was paid to the country rocks in each case so as to determine the geological factors that influence the formation of ore deposits, and thus to establish certain relationships which should be of value as suggesting new regions of promise to the prospector.

Acknowledgements.

I desire to express my high appreciation of the kindness and hospitality offered me by the owners and managers of the mines visited, and also by the widely scattered companies of prospectors who have always shown themselves ready to aid with suggestions or to serve as guides to the neighboring locations. As usual, the excellent maps published by the Geological Survey of Canada have been of the greatest service. It is most desirable that the remaining sheets covering the geology of this interesting and economically important region should be in the hands of prospectors and geologists as soon as possible.

THE UPPER SEINE REGION.

Routes to the region.

There are several ways of approaching the Upper Seine region, where a number of promising mines are now attracting attention, all by canoe in summer, though in winter a sleigh road leads south from Bonheur station on the Canadian Pacific to Sawbill lake and lake Harold, about thirty miles to the former place and sixty to the latter. The canoe routes commonly used are three in number, one from Bonheur, beginning with a two-mile portage; the others from Savanne station. The choice of route turns largely on the part of the region it is designed to visit. In previous journeys I had traveled over the Atik-okan route, which leads southwesterly from Savanne over Lac des Mille Lacs, Windegoostigwan, Crooked Pine and other lakes to the Atikokan river, which enters Steep Rock lake, an expansion of the river Seine. This year, on the advice of Mr. Hume Proudfoot, who has covered the ground very thoroughly, I took a more northerly route, following the western arm of Lac des Mille Lacs, Round lake and Partridge lake to the outlet of Partridge river near Reserve island. This route is several miles shorter than the more southern one, and on the whole is preferable.

Pine Point on Lac des Mille Lacs.

No stops of any length were made on Lac des Mille Lacs except for a night camp on Pine point, which projects from the north shore and nearly bisects the lake. Here we found that a mass of eruptive granite comes up through a gray, fine grained, massive looking rock, perhaps Huronian. At the contact of the two there is a strip of gray porphyroid containing large white crystals of plagioclase felspar. Lac des Mille Lacs has been referred to frequently in various reports, and requires no detailed description. The western bay, which we followed, is very confusing to a stranger, being long and winding and full of islands. Its shores are mostly Laurentian, but with some Huronian areas which may be worthy of the attention of propectors.

A portage of about half a mile with a fall of sixty-five feet (aneroid) leads across hills and a muskeg to a wide marsh over which canoes must be

pushed by main force through meadows of reeds and horsetails into a very small creek, not at all certain as to the course it shall take. The bends are so sharp and the creek so narrow that Peterboro' canoes often have to be lifted over. The creek empties into a long lake from which it issues as crooked as ever but wide enough to paddle on, and after some miles of windings enters Round lake, which as usual in lakes of the name is very far from round. The waters of this chain of lakes and streams are brown and have a rainy taste, but are better than those of Lac des Mille Lacs. No brulé is seen after leaving the latter lake, and a few clumps of fairly good red pine occur. The shores of Round lake are low, with some beaches of yellowish brown coarse quartz and felspar sand ; sometimes also half rounded pebbles and boulders of Laurentian and Huronian rocks ; while rounded forest-covered hills rise behind.

Lac des Mille Lacs to the Seine waters,

through Round lake

The creek flowing out of Round lake wanders through marshes and then opens into a pretty nameless lake, three or four miles long, enclosed by Laurentian rocks. Here there is an old brulé, perhaps of twenty or thirty years ago, and some red pine. There follows a sudden rapid with a portage, noted on the Geological Survey map as fifty-eight chains long, much of it over morainic boulders of granite. A quarter of a mile below there is a series of cascades over granite, and finally the creek enters Partridge lake, which the route follows for six miles. For the whole distance one sees only gneiss or granite until the large island which fills the west end of Partridge lake is reached, where some strips of Huronian schist vary the monotony. Along this part of the route there is much old burnt ground, though a few groups of red and white pine remain ; and on the lake itself portions of the shore burnt over two years ago present a very desolate appearance.[1]

and Partridge lake

A mining location was taken up years ago by the McKellars on Partridge island and the adjoining shore, but it is unnecessary to give any further description of the property, no work having been done on it since my visit in 1894 [2]

Partridge creek flows from the west end of the lake of the same name, from the point where two long arms of the lake unite enclosing a large island. It passes through some small lakes and is varied by three rapids with short portages before falling into the river Seine not far above Island falls. Practically the whole distance is through Laurentian rocks.

Near the mouth of Partridge creek we encountered two prospectors, Messrs. McLean and Nettles, engaged in panning a specimen of quartz which showed a beautiful train of gold in the pan. They stated that the quartz came from a long vein, two feet wide, running through a granitoid rock

Gold hunter on Partridge creek.

The character of the country changes as the river is approached, becoming flatter and more swampy. The Seine, which starts from a long northwest bay of the many armed Lac des Mille Lacs, and curves to the southwest before Partridge creek enters it, is already a wide, fine river. It has

Seine river

[1] A description of the effects of this fire is given in the Fourth Report, Bureau of Mines, 1894, pp. 96, 97. [2] Ibid. p. 58.

formed low and narrow flood banks covered with a thin row of trees, chiefly alders and willow, with occasionally ash and soft maple, but sometimes broken by evergreens, such as spruce, tamarack and pine. Behind the raised banks are wide marshy lagoons. The whole effect is of a milder climate and more luxuriant growth than that of the previous part of the route.

Island falls.

The Island falls on the Seine are wonderfully picturesque. The river divides into several channels cutting into the glacially smoothed granite or gneiss, so that from below one sees four falls of different sizes, the amber colored water and white foam making a fine contrast with the greenish rock and dark evergreens of the background. The amount of fall is twenty-three feet as determined by aneroid. If the adjoining gold mining region develops as is hoped these falls should form an important source of power for milling or other purposes.

The granite at the falls is of the protogine type, and contains large inclusions of green schist and a few small quartz veins.

Reserve island.

A mile below Island falls the Seine forks, enclosing Reserve island, which is three miles long by a mile and a half in width. This part of the Seine presents great variety, swift water flowing between rock walls and placid lake expansions.

LOCATIONS ON OSINAWE LAKE AND RESERVE ISLAND.

Mining locations on Osinawe lake.

As I had failed two years ago to reach some locations on Osinawe lake, since fires were raging on the long portage from Sabawe lake to the south, we took this opportunity of visiting them. Osinawe lake drains by a very small but fairly navigable stream into the southwest angle of the Seine, where it widens to enclose Reserve island. The valley is filled with muskeg and morainic boulders, and there are two portages, the lower of about four chains (not forty-one as misprinted on the geological map), and an upper one of fifteen chains. The locations are at a narrows where the geological map indicates a band of Couchiching as crossing the hornblende-granite gneiss. On R 71, owned by the Messrs. McKellar, there is a mass of quartz about twelve feet wide enclosed in a greenish, coarse grained granite of the protogine type, containing black mica. The quartz is reddish and good looking, but the deposit has not been at all developed and can be traced only a short distance. Higher on the hill there is sericite schist with stringers of quartz, and stripping might show a continuation of the vein beyond.

Locations on Reserve island.

Several locations have been taken up on Reserve island and the adjacent mainland, and at the time of our visit Mr. Hume Proudfoot had a small camp and was engaged in developing some veins to the northeast of the island. On AL199 two shafts had been sunk to the depth of about twenty feet on a bedded vein containing white and greenish quartz with some galena and iron pyrites. The vein had well slickensided walls, at least at some parts. The vein at the second shaft is nine or ten feet wide and nearly vertical, and has a strike of about N. 20° E. The country rock is protogine granite, but in places chlorite schist shows itself associated with the quartz On AL197 there is a vein of white quartz at times four or five feet wide, dipping strongly

to the northwest. This contains some green schist with the quartz, and has one good wall of granite. Some free gold is found in it. On the same location a vein of very fine grained sugary looking quartz has been stripped for seventy-five feet, and is at one point ten feet wide. Green schist partly replaces the quartz in places. All these veins have green schist interbedded with the quartz or replacing it, and all are enclosed in granite.

The work done at the time of our visit (July 7) was not sufficient to prove the real value of the veins, which, with a number of other veins in the vicinity, had been found by McLean and Nettles. Mining is carried on here under considerable difficulties, all supplies having to be brought in by canoes from Savanne over the route which we had followed, the expense being $3 or $4 per hundred weight, or $60 per ton. In winter however it is probable that a sleigh road could be provided at no great expense. The charcoal used in the smithy was burnt on the spot, but the charcoal burners complained that there was no soil and that the coarse sand did not cover the heaps of wood properly.

Near the south end of Reserve island a location, HP498, has been taken up by those enterprising prospectors, Messrs. Landon, Lahey and McDonald. Here a vein may be followed for perhaps half a mile from northeast to southwest, with a dip of 60° to the northwest. It is very irregular in width, being sometimes two or three feet wide and at others only a few inches, and the granite enclosing it has been sheared and probably faulted. Some of the quartz looks well and is said to give good pannings, but other parts are less promising. This vein was found on a patch of burnt ground and can readily be followed across country; but much of the region is still covered with moss and green timber, so that the rock is scarcely to be seen except along shores

HP498.

During my stay at Reserve island Mr. R. Swanson, foreman for Mr. Proudfoot, who was away at the time, served as guide and gave every help and information required, for which I desire to express my thanks.

HAWK BAY LOCATIONS.

About four miles below the Reserve island camp after passing a short rapid there is a small lake expansion, on the north side of which some locations have been surveyed. We examined 325X, which is said to be an extension of 324X on which the Hawk Bay mine is placed. At that time there had been no development, and there was no one to be seen in the neighborhood. We found a well defined fissure vein a foot or two feet wide, and followed it for a quarter of a mile. The vein had a strike of 15° to 25° east of north, while the country rock, a grayish granitoid gneiss generally of the protogine type, though partly flesh-colored, has a well marked foliation with a strike of 130° east of north. The quartz looks well, is rusty and contains some carbonate and copper pyrites. Here also a little green schist is mixed with the quartz or lies beside it. This vein impressed me more favorably than any other in the region.

324 X and 325 X.

Since our visit these two locations have attracted considerable attention, and it is stated are now being worked with very good prospects. They were

reported upon by Mr. J. H. Chewett of Toronto, who speaks very favorably of them. Assays made of samples chosen carefully so as to give a true average of the vein showed gold to the extent of $21 per ton. As Mr. Chewett estimates the cost of mining and milling at about $6 per ton, there seems to be a good margin for profit.

Lynxhead Falls location.

Below Hawk bay morainic country shows itself, and in about three miles Lynxhead falls is reached, where several locations have been taken up. At this point the gneiss is very Laurentian in look, having lighter and darker bands, mostly gray in color. We saw no veins that appeared to be of importance, perhaps because we had no guide to show us the locations. An aneroid reading makes the fall about nine feet.

AROUND SAWBILL LAKE.

Sawbill lake.

On July 8 we reached Sawbill lake, which forms a part of the Seine river chain of lakes and connecting stretches of flowing water. This lake projects five miles to the northeast from the point where the Seine turns to the south. It is a fine sheet of water, with few islands and mostly wooded shores, some handsome groves of pine giving beauty to the outlet of the Seine where a picturesque Indian encampment provides a human interest.

Sawbill mine.

The buildings connected with the Sawbill mine cannot be seen from the mouth of the lake, since they are placed near a small bay three miles up the southeastern shore. The vein on which the mine is working lies half a mile inland, and the shaft is being sunk at a depression between two hills at an elevation of about one hundred and fifty feet above the lake as determined by our aneroids. The vein where the shaft begins is about four feet wide, dips 58° to the east and can be followed for about a quarter of a mile. Its general course is 25° east of north. The shaft had been sunk to a depth of 49 feet on July 9, and the vein at that level had widened to six feet. The quartz looks very well and contains pyrite, chalcopyrite, galena and some free gold. The country rock is an imperfectly foliated gneiss, having a strike of 10° east of north. Some parts of it are rather coarse grained and slightly flesh colored, but other parts, especially near the vein, are fine grained, pale green, have slickensided surfaces and may be called protogine. A microscopic examination shows that much of the rock is a tolerably fresh biotite granite gneiss, but that the parts near the vein are greatly altered, the quartz being crushed and the felspar turned almost completely into sericite. In some respects this rock resembles the granite of the Shoal Lake region, but contains much less plagioclase and is less generally weathered to the greenish protogine variety.

The vein and the country rock.

At the time of our visit the manager, Mr. F. S. Wiley, was absent, but Mr. George Willoughby, engineer, provided all necessary information. At the shaft there was a twenty-two horsepower hoisting apparatus made by Miller Bros. and Toms of Montreal, a twenty-five horsepower boiler and two steam pumps, though the small amount of water entering the shaft was at the time raised in buckets. The ore was brought up in buckets and dumped into a car, the mouth of the shaft being covered with a trap door at the moment.

Machinery.

Fourteen men were then employed, six being miners ; and three Indians brought in supplies from Bonheur on the railway, a canoe journey of thirty-three miles, including thirteen portages, all short except a two mile portage at Bonheur. Employés.

On the lake shore there were cooking and sleeping camps, an office, storehouse and stable, all of an inexpensive character. To the thirsty paddler under a July sun with nothing better to drink than the tepid and brownish water of the Seine, a well of excellent water formed one of the most attractive features of the camp. The camp.

By the kindness of Mr. Wiley I have since been informed that up to Jan. 11 the main shaft had reached a depth of between one hundred and thirty and one hundred and forty feet. The south drift at the sixty-foot level had been driven seventy-five feet and the north one about fifty-five feet. Drifting had just been started on the second or hundred and twenty-foot level. In the first level the vein was the full width of the drift and more both north and south ; and was equally strong, if not stronger, at the bottom of the shaft and in the second drift. A ten-stamp mill of the most modern pattern has been purchased, with all other machinery and supplies to carry on the work. "The ore appears to be quite up to the standard of what you saw when you visited the property, and possibly a shade better." Progress of the work.

Since July other interesting and important finds have been made in the Sawbill region, especially Mr. James Hammond's broad band of gold bearing rock, probably low grade but very extensive. This is perhaps a fahlband, though sometimes spoken of as a dike. Hammond's discoveries.

Near the foot of Sawbill lake a stream flows into it on the west side from Clearwater lake, the water of the latter being transparent as crystal and almost alarming to the canoeman familiar with the turbid waters of the Seine. Every rock and snag shows distinctly and one expects to run aground. Near the mouth of Clearwater creek there is coarse reddish, somewhat porphyritic granite ; and a little farther south green coarse grained quartz-biotite diorite. Clearwater lake.

All the gold bearing veins thus far described from Partridge lake to Sawbill are in areas colored on the map of the Geological Survey as hornblende-granite gneiss of the Laurentian, except the upper part of the shores of Sawbill lake, which are colored as biotite-granite gneiss. It seems doubtful if this subdivision of the two varieties of gneiss can be so sharply carried out, but of course it is impossible to indicate each minor change on a map of so small a scale. The occurrence of such promising gold deposits in rocks having all the petrographical characters of the Laurentian, and sometimes miles away from the nearest areas of Huronian, is a matter of the greatest interest to prospectors, and suggests that other areas of greenish or gray gneiss and granite mapped as Laurentian are worthy of careful attention. Geological character of the district.

DOWN THE SEINE RIVER.

After one or two short rapids the Seine, which turns south on leaving Sawbill lake, enters Moose lake, a beautiful sheet of water with unburnt shores and many points and islands. Below Moose lake there are several rapids Moose lake and Steep Rock lake.

and swift currents before entering Steep Rock lake, the last three or four miles requiring a number of portages. On this part of the river we find Huronian schist and the character of the scenery changes, the shores and hills becoming rougher, less rounded and more picturesque, while the rapids are more tortuous and the portages bad. The relationship of scenery to the rocky structure of the country is well shown here.

Just before entering the right upper corner of the "M" of Steep Rock lake the river plunges over walls of rock, forming a very fine fall with a height of thirty-five or forty feet as determined by aneroid. The rocks at this point are much confused, since the Huronian schist and greenish granite come in contact and are largely intermixed.

Steep Rock lake is one of the most beautiful as well as geologically interesting parts of the Seine river system, and may have a special importance in future from the supply of limestone afforded by its shores, something entirely lacking in other parts of our western gold region. Its geology was touched on in the report for 1895[3] and a brief reference made to the interesting work of Mr. Henry Lloyd Smyth, who found evidences that the rocks of the region had been bent into a horizontal "M" shaped fold out of which the lake had been carved.[4] As I had not read Mr. Smyth's paper before my former visit, some hours were spent this summer in going over part of the ground investigated by him ; but a discussion of the results will be left for another time.

It should be stated here however that the mapping of the east shore of the lake is somewhat incorrect as given in the Seine river sheet of the Geological Survey, Keewatin schist being indicated where whitish granite is the prevalent rock.

Below Steep Rock lake the course of the river Seine has been sufficiently described by Mr. Blue and the writer,[5] and will require little further mention.

Progress of operations at Harold lake mine.

A visit was made to the Harold lake mine, two or three miles below Steep Rock lake and a mile or two north of the river. We found work progressing at several points of the numerous veins on this property and considerable advance had been made since my last visit, a year previous. To save the trouble and expense of a separate visit by Mr. Slaght, I was instructed to examine and report upon the condition of the mine. My report is reproduced here as showing the changes made during the year.

Inspection of the mine.

"July 11, 1896. On behalf of the Inspector of Mines I have this day visited the Lake Harold property, and have to report that several advances have been made since the last report. In the mill two four-foot Frue vanners and an upright fifteen horsepower boiler have been added. No. 2 drift has been extended 65 feet since the last report, and now has a length of 127 feet. Stoping has been done from 80 feet in to 105 feet, and to a height of 20 feet to the top of the drift. The hanging wall is of decomposed material which

[3] Fifth Report Bureau of Mines, p. 71.

[4] Am. Jour. Science, vol. xiii, Third Series, 1891, pp. 317-331.

[5] Fifth Report Bureau of Mines, 1895, p. 63, etc., and p. 149, etc.

needs close attention, but sufficient timbering has been done to make things safe. At a distance of 60 feet in, a shaft 6 by 9 has been sunk to a depth of 48 feet 7 inches below the bottom of the drift. The shaft is full of water and is now properly covered.

"On No. 1 drift a shaft has been sunk to 17 feet, but is now filled with water.

"A tramway has been constructed from the mill to No. 2 drift and is now in running order. On the shore vein a shaft has been sunk to a depth of 36 ft. 9 in., and at a depth of 27 feet a drift has been started north and is now in ten feet. The shaft has been properly closed below the level of the drift.

"At present thirteen miners and three surface men are employed. In addition there are two engineers and one mill man employed. Mr. F. N. Gibbs is still superintendent."

To what has been stated in the report, it may be added that the greenish protogine granite of lake Harold and Steep Rock lake is quite like the country rocks of the upper Seine gold deposits, and not unlike the eruptive granite of Shoal lake. Country rocks.

After Harold lake no delay was made until we reached the lumber road which runs east from a bend of the Seine five or six miles below Calm lake. As a number of locations have been taken up here in the Keewatin schist, it seemed well to have a look at the country. Locations below Calm lake.

A trail goes eastward from a reedy bay and can be followed readily as far as the hills. Near the river there is sandy soil, with jackpine and some muskegs; but inland the ground rises as rocky hills to a height of two hundred and seventy feet, as shown by aneroid. There are several small lakes in sight from the highest points, and it is said there is an Indian canoe route across to Calm lake.

No work has been done, so far as I can learn, on any of these locations, and we saw only small quartz veins interbedded with the green schist, nothing of any importance. We had however no guide to show us the more promising spots, and in such a country a guide is very necessary, so that some points of interest may have been overlooked.

Four miles below the bend there is a series of short rapids separated by short stretches of swift current. Instead of portaging at each rapid we used a single long portage on the south shore, a well beaten path following an old lumber road in part. The "big" portage is over tolerably level land, having rich black soil and a luxuriant growth of trees. It is probable that land enough for a few good farms could be found here. On the whole it is a saving of time and labor to make the three short portages instead of one long one. Portages on the lower Seine.

A final portage around Sturgeon falls and some miles of smooth paddling brought us to the last important enlargement of the Seine, the now well known Shoal lake.

THE SHOAL LAKE REGION.

Progress in the district.

The Shoal Lake region, which two summers ago did not possess a single house and had scarcely at all been developed, had advanced greatly since the previous summer ; but there was still an air of doubt as to the future when we arrived on July 18. Only one mine was working, the so-called Ferguson mine, and that with not a very large force. But just at that time the energetic Mr. Foley, who had been absent for some months to obtain capital, as it was said, returned and made all preparations for pushing work on AL 75 and 76.

Some days were employed in making a more complete examination of the geological structure of this important region than had been done before, but the results of this work and a sketch map of the geological formations will be given at another time.

Ferguson mine.

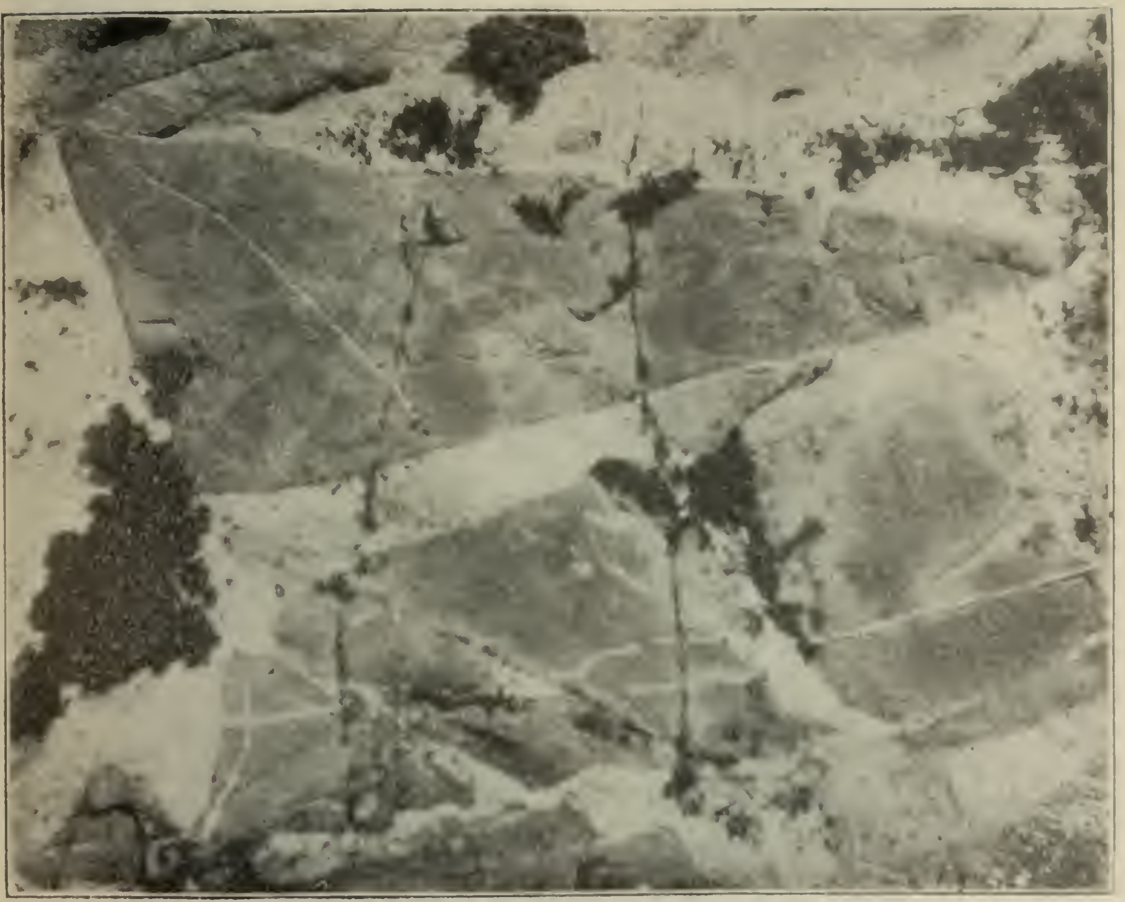
The first property visited was the Ferguson mine, as it is generally called, consisting of the locations AL110 and 111 and K223, which originally belonged to Messrs. D. L. Kelly, Dan. Mosher, Rufus Mosher, Robert Mosher and George Calder. It was purchased by Mr. Wm. Douglas Ferguson for the Seine River Gold Mines Co., of London, England, a company having a capital of £100,000 in £1 shares. Mr. Arthur B. Whiteley was manager when we were there. The mine is reached from the village of Mine Center on the north shore of Shoal lake by a Government road which runs across the peninsula to Bad Vermilion lake. It is at the northeast end of the area of protogine granite, in which the best known gold bearing veins of the region are found. The road leads over swampy ground for the first half mile, but this part may be avoided by paddling up a sluggish creek to a bridge. Then follows a stretch of perhaps half a mile of level good soil, then a gentle slope of barren sand and silt until the bare granite begins to show itself. Three veins in particular deserve attention, the Daisy vein, the Finn vein and the Government vein, the last having been found during the making of the Government road.

Development work on the veins.

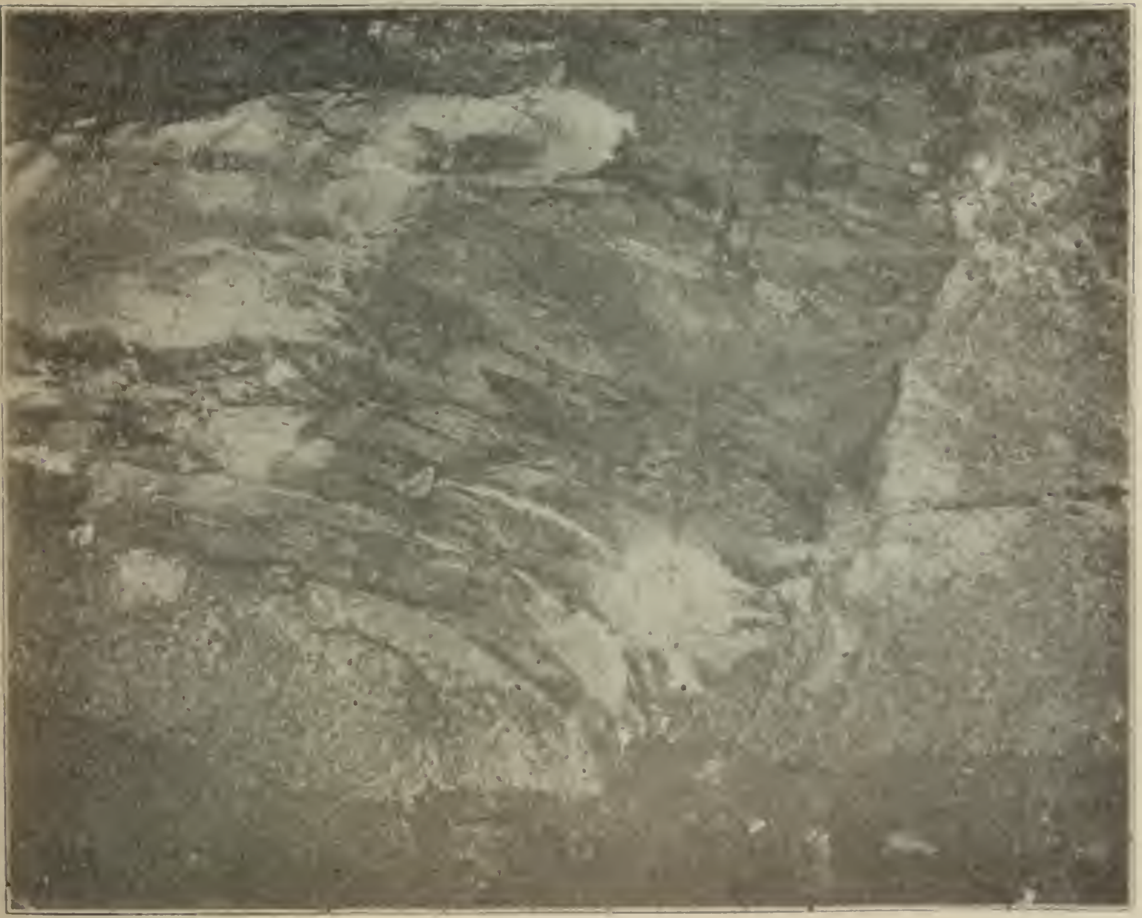
The Daisy vein averages a foot wide, has been followed 800 feet, and has been tested by sinking two shafts, each fifty feet deep, and by driving in an adit from the east end. The quartz is bluish. The Finn vein is 900 feet long and runs to the edge of the granite, and has been opened up by a seventy-foot shaft. The Government vein runs parallel to the Daisy, and has been stripped for 1,000 feet with an average width of about two and a half feet. This vein carries good looking quartz and sometimes shows handsome specimens of free gold. It is however very variable in width and contains a good deal of sericite schist, or perhaps altered porphyry, the latter sometimes wholly replacing the quartz. A little work has been done also on the Big vein, which is three and a half feet wide and 900 feet long.

The camp.

At the time of our visit there were twenty-three men on the roll and several buildings of a cheap character had been put up. There were women and children in the camp and an excellent cook who set out a table provided with a clean white cloth, napkins and real cream from a cow kept at the camp, novelties of a very refreshing kind in this out of the way region.



Keewatin schist in gneiss, south end of Whitefish Bay.



Gneiss enclosing Keewatin schist, south end of Whitefish Bay.

Sunday Camp on Long Bay.

View at Camp Bay, Lake of the Woods

Indian Conjuring Booths on Yellow Girl Bay, Lake of the Woods.

Indian grave on Hay Island, Lake of the Woods.

Chief Peter of the Poplar Point Reserve.

Since we were at the Ferguson camp much advance has been made, and it is reported that the results obtained with a three-stamp prospecting mill have been so satisfactory that a larger mill is to be put up and work begun on a more important scale.

What is generally called the Foley mine, consisting of three locations, AL 74, 75 and 76, lies three miles southwest of the Ferguson mine, near the northwest shore of Shoal lake. The locations, originally owned by the pioneer prospectors of the region, the Weigand brothers, were in July the property of the Ontario Gold Mines Co , with Mr. R. A. Demmé of Detroit as president and Mr. J. C. Foley as manager ; but a new company has since been formed to work the property. Foley mine.

There are a number of important veins on this property, and one, the Bonanza in AL74, has been more thoroughly developed than any other in the region. On July 17 a shaft had been sunk to a depth of two hundred and ten feet, and headings had been driven at depths of 100, 150 and 200 feet respectively, the whole length of drifting amounting to 325 feet. The vein averages two and a half to three feet in width and is very uniform and well walled. Mr. Foley states that the average of many assays of the quartz, which looks very well and carries free gold, is $20 per ton free milling and $5 in the concentrates. The richest rock was obtained at 190 feet. A shaft has been sunk 113 feet on what is supposed to be the continuation of the Bonanza vein in AL75, 1,200 feet from the deepest shaft, and the quartz is there nineteen inches wide. In all there are eleven veins on AL74, running in width from eighteen inches to eight feet ; and seven veins on AL75, including the continuation of the Bonanza. There are also several veins on AL76, where the mill and other buildings are erected near the shore. A number of other veins besides the Bonanza have been more or less developed, and it is reported that a small but very rich one has been discovered since our visit. Veinage of the property, and extent of the workings.

During the past winter a twenty-stamp mill has been erected near the shore, a tramway bringing the ore from the mine. After many difficulties and delays, owing largely to roundabout and troublesome means of communication, the mill has been set to work and, it is reported, has produced about $6,000 worth of gold in a three weeks run. A twenty stamp mill in running order.

The Lucky Coon or Hillier mine, on 655 P, where there is a fine stamp mill, was not working last July and has already been described in the last report of the Bureau of Mines.[4] During the autumn some Edinburgh capitalists bonded it and sank the shaft deeper than before, finding, it is stated, some very rich ore, but for some reason they have discontinued operations. No other properties had been developed to any important extent last July, though there was a great renewal of activity in this most promising mining region. Lucky Coon or Hillier mine.

There are two other areas of granite associated with anorthosite to the west of the Shoal lake area and south of Bad Vermilion lake, but the granite Other granite areas.

[4]Fifth Report, 1895, pp. 155-157.

here is of finer grain and different in appearance. Many locations have been taken up in and near them, but so far as I am aware no serious development work has been done on any of them.

A GOLD AREA NORTH OF BAD VERMILION LAKE.

North of Bad Vermilion lake and around Turtle lake.

The district between Bad Vermilion lake and Little Turtle lake, a mile or two to the north, attracted much attention last summer, and we spent several days in visiting some of the recent finds. Practically the whole strip has been located, and very rich gold specimens have come from some of the properties. A good portage a mile and a quarter long leads from the north side of Bad Vermilion to the shore of Little Turtle lake, from which most of the prospecting has been done. Granite or gneiss of Laurentian look comes in eruptive contact with green Keewatin schists and more massive greenstones (diorite or weathered diabase) along this shore. Mr. W. S. Stone has locations east of the portage; Mr. Jon Rode and his two partners (all Norwegians, but commonly spoken of as the "Swede Boys,") have locations west of the path; and "Doc" Gardener and others have taken up locations toward the western end of Little Turtle lake. All of the veins are of a bedded character, some with quite wide bands of white or rusty looking quartz, others having the quartz intimately mixed with schist, and still others that might be called fahlbands, since the quartz is a minimum and the schist is strongly impregnated with sulphides.

Good promise of the "Swede Boys" location.

The Norwegians have built two good log houses and have an excellent garden, so that their work has a permanent look. The vein at which they have done most work is near the water's edge on 238E. Here a fahlband of dark schist with interbedded quartz has been sunk upon for a few feet, and the quartz crushed in two large mortars with pestles or stamps attached to spring poles. Mr. Rode informs me that last winter they crushed three and a half or four tons of rock in these mills, the third man panning the crushed quartz in an amalgamated pan. Not all the gold was saved, but they secured $175 or $200 from their work, amounting to about $3 or $4 per day for all three. If Mr. Rode is correct, and I have no reason to doubt his statements, the rock treated must have run about $50 per ton, though the ore does not look very promising. An assay of some ore taken by myself yielded $34 per ton.

"Doc." Gardner's location.

On G61, a location taken up by Mr. Gardener, very rich ore is found, a seam of rusty quartz two feet wide showing free gold in almost every piece broken off; and it is said that two or three feet of the adjoining rock pans well. From this rich outcrop the band of quartz has been traced ten chains to the eastward, and Rode and Stone believe that the vein crosses their properties. This bedded vein has no distinct walls, and in a region so largely moss-covered as this there is much doubt whether it can be traced so far. Only actual mining will prove the value of these rich but perhaps uncertain ore bodies.

"Doc" Gardner's location has since been sold to Mr. Preston and partners, and is now known as the Oliver mine, from which very rich specimens have come.

In our examination of the region we found that gneissic or granitic rock crops out not far from the shore of Bad Vermilion and runs to some extent at least through the little explored region west and southwest of the locations already taken up. Doubtless these eruptive contacts of Laurentian and Huronian deserve careful prospecting.

Eruptive contacts

Following the Seine river to its mouth at Seine bay, Rainy lake, we spent a day or two tracing the boundaries of what is no doubt a westward extension of the granites and anorthosites of the Bad Vermilion region. The results, which modify the arrangement as given on Lawson's generally admirable map of the Rainy Lake region, will be given at another time.

Granites and anorthosites of the Seine bay shore.

On the way down the bay Scott island, a large mass of almost white anorthosite (gabbro with little or no augite), was visited and a shaft now mostly filled with water was examined. Quartz with pyrites and slickensided talc lay on the dump, but the ore looked unpromising. Assays of two samples gave no gold in one and \$6 per ton in the other. Hitherto no valuable gold deposits have been found in the anorthosite, and it will be interesting to see how Scott island turns out.

Scott isl location.

On July 23 we reached Fort Frances, and without delay refitted for our trip north to the Manitou.

THE MANITOU REGION.

A day's hard paddling with adverse winds brought us to Manitou sound, the northern extension of Rainy lake, through beautiful scenery, but monotonous geologically since it is almost wholly gneiss. Climbing the steep hill which forms the short portage past the Devil's cascade we reached the beautifully clear waters of Manitou river. The cascade is about forty feet in height, according to aneroid readings, and with its foamy rush forms an impressive bit of scenery.

T Dev s cascade on Manitou river

Seven portages with stretches of river or small lakes between bring one to Pickerel lake. We found that the swift currents or rapids separating this lake from the southern end of Manitou had almost disappeared, so that the two lakes were practically on the same level.

Pickerel lake.

Since of late most of the prospecting has been done on the Upper or Little Manitou, we proceeded without delay to the upper end of this straggling but beautiful lake, and found the water unusually high.

LOCATIONS ON THE MANITOU LAKES.

Mr. E. B. Haycock, who was at his mining camp near the southwest end of Upper Manitou, was good enough to serve as guide to that end of the lake. A visit was made to the so-called "Swede Boys' Location," (HP304 or HP384) to see the small placer which they had been working, so far as I am aware the only placer mine in Ontario. The point is about a mile southwest of the west end of the lake, and is reached by a good trail. The placer ground consists of the mud of a swamp, with small augular fragments of quartz and schist, etc., evidently broken or weathered off from an

Placer ground near Manitou lake.

adjoining small bedded vein in Huronian schist. It is not a river or creek deposit as in ordinary placers, and is probably of very limited area. The sluice was supplied with water by pumping from the swamp, and the whole arrangement had an amateurish look. I am informed that a few dollars worth only was obtained from the placer. On panning their tailings we found a good string of colors, showing that not nearly all the gold was extracted.

The source of the placer.

The narrow vein, evidently rich in gold, whose decay furnished the debris of the placer, is from six to eighteen inches wide, striking parallel with the schist, about north 25° east, and dipping 65° or 70° to the southwest. A specimen taken from this vein assayed 38⅓ oz., and must have contained free gold. There is a second nearly parallel vein near by having a width of about five feet, containing white quartz with much sulphide. This has been traced more than a quarter of a mile and is said to have yielded $13.90 per ton on a mill run.

Rocks of the district.

The rocks in this district are largely green chlorite, or chlorite hornblende schists and massive green rocks, altered diabases probably ; but grayish, fine grained very schistose gneiss also occurs, the former rocks having the look of the Keewatin, the latter of the Couchiching. The Laurentian, which was shown to exist on the northwestern bays of the Lower Manitou two years ago, is stated to crop out two and a half miles west of the Swede Boys' location.

Location D14 on Manitou lake.

On the return from the placer, D14 at the end of the lake was visited to see a bedded vein of quartz said to have been traced two and a half miles. We found it to have a strike of north 30° east, and to be four or five feet wide at some points. The quartz is rather white, but contains sulphides and carries free gold. The country rock is a very fine grained gray gneiss, looking like Couchiching. The walls of the vein are indistinct, the rock being broken.

Haycock's camp and locations.

The most important camp on the lake when we were there was that of Mr. Haycock, who represents an enterprising Ottawa company consisting of Messrs. C. W. Mitchell, H. F. Brady and E. B. Haycock. The company owns locations 138, 139, 140, 141D on the Upper Manitou, their house and mill being prettily situated on the shore of 141D. The camp is one of the cleanest and neatest to be found in the region. The mill house contains a two stamp Tremaine mill which cost, laid down, about $1,800. The buildings are made of logs and whip-sawn lumber, the whole cost of outfit, including house, mill, stable and blacksmithshop, being about $2,500. The mill can treat about six tons per day, according to Mr. Haycock, who served as millman, and ran in all seventy hours, treating about eighteen tons of "job lots" from various veins in the neighborhood, the average value secured being about $25 per ton. The mill is stated to have worked excellently. Nine men were employed on the average during the season ; but work had just stopped, all the men but one being paid off the day before we arrived, July 27.

Deposits of various kinds are found on 141D, and shafts have been sunk from ten to twenty feet on two veins near the mill, the nearest being small

[7] Fourth Rep. Bur. of Mines, 1894, p. 64.

and irregular but very rich. The "Big Mill" vein a few rods away is a sheared band of quartz and gray schist, nine feet wide with a strike about east and west and a dip of 75° or 80° to the south. It is in a fine grained, massive, green gray diabase. The quartz is often white, contains iron pyrites of two colors and copper pyrites, and looks like Rode's vein on Little Turtle lake.

A dike of gray granite forty feet wide runs northeast and southwest through a green gray schist and contains many small quartz veins and stringers, said to carry gold. The granite itself is often impregnated with sulphides and is stated to pan gold at times, but a specimen assayed at the the School of Science, Toronto, contained none. Masses of slender black tourmaline crystals occur frequently in the quartz of some of these veins.

Mr. Haycock, who was most kind and hospitable, expressed himself as satisfied with the results of his mill tests, but pointed out the great need of a summer road to lake Wabigoon. The present winter road, seven miles long, could he thinks be made passable for summer travel at a cost of perhaps $1,500.

On D138 near the north end of the main expanse of Upper Manitou there is a large, irregular mass of quartz, hardly a vein, in greenish schist. This has been traced for two or three hundred yards, running from two or three to eight and even to forty or fifty feet in width. Some of the quartz looks well but the mass is low grade, the highest assay reported being $10.60. Northern shores of the Upper Manitou D138.

At the exit of Upper Manitou, where a short swift current empties into the lower part of the lake, we found encamped Messrs. A. Leullier, Paul Gasse and Louis Gasse, all Old World Frenchmen. These gentlemen were so kind as to serve as guides to the upper part of the lake, and did us good service in that capacity. They were camped on location 165P, which includes 165P. the short current, and called our attention to several dikes of sheared quartz porphyry cutting the schist conglomerate which forms the general rock at that point These dikes are generally accompanied by some quartz and are said to carry gold, especially in the quartz. An assay of the rock made in the laboratory of the School of Science yielded a trace of gold only.

A long bay leads about two miles northeast of the main body of Upper Manitou, and includes between its northern end and Mud and Summit lakes an area in which gold has been found at many points. A number of parties were engaged in this region when we visited it with the Frenchmen, and several locations deserve mention.

On McA28, some distance north of the bay, Messrs. Ohlsen and McKenzie McA28 were opening up a bedded vein in schist about six or eight feet wide, so far as one could tell from the small amount of stripping done, very rich in gold, some brilliant specimens having been obtained here. The dirt overlying the vein pans richly, the gold being very coarse compared with that from some parts of the region. 382P just at the head of the bay contains a bedded vein of sheared rock and quartz, seemingly a dike in schist. It runs about east and west, is sometimes twelve feet wide, and is said to pan gold. HP301, belonging to Crawford, Kempfer and Doyle, is only a short distance

away and affords one of the few examples of a true fissure vein which we saw on the Upper Manitou. It has a strike of 20° or 25° east of north, can be traced about a quarter of a mile and is sometimes four or five feet wide. It had not been sufficiently stripped when we saw it to make a very satisfactory examination, but the property looked very promising. A second smaller vein, about two feet wide, is said to extend all across the location. A hill top near by rises a hundred and ninety feet above the bay as determined by aneroid. Mining operations have since been undertaken on this property, which is said to be turning out well.

A variety of ore deposits.

At this end of Upper Manitou the country rock is largely agglomerate; to a less extent pale greenish schist and diabase; and the ore deposits are of great variety, fissure veins, bedded quartz veins, schist impregnated with sulphides and dikes of porphyry, all carrying gold to a greater or less extent.

Locations on Mud lake and Mountain lake.

On July 30 we went from Manitou narrows up to Mud lake, where many locations have been surveyed recently, and visited first two locations on Mountain lake two miles up a small stream to the east. On the northeast side of this small and shallow sheet of water we found a curious mixture of rocks, a brown quartzite beautifully veined with black and white, a breccia of quartz and a brownish weathering carbonate, a dark greywacke and a green schist weathering brown. A band of good looking quartz shows on one side of the quartzite and is reported to carry free gold.

The "mountain" from which the lake gets its name consists of a hard greenish diabase, which has resisted erosion better than the surrounding schists and so stands up as an oval boss rising two hundred and seventy feet above Mud lake. Its precipitous front toward the creek is very mountain-like, having a talus of large angular blocks for the first hundred and fifty feet, and then a vertical cliff which can be scaled at only a few points. The faces of rock are covered with "tripe de roche," the brown lichen which is boiled and eaten when starvation overtakes the Indian. From the summit there is a grand view of Manitou and many miles of wild hilly country covered with forest.

On the west shore of Mud lake many locations have been surveyed, but we were able to visit only a few of them. On S28, belonging to Messrs. Landon, Lyons and Rice, a vein which has been traced for three hundred and fifty yards cuts diagonally across the slaty schist and has at some points a width of three feet, but is quite irregular in this respect. Two pits opened upon it, the deepest only ten feet, show quartz with green and brown streaks, and have produced some handsome specimens of gold.

HP376.

A singular deposit is found on HP376, belonging to Messrs. Lahay, Rice and Quirk, gold being found in small quantities in a very cleavable green schist, apparently a sericitic or chloritic quartzite, much like the rock of the Quartzite mine near Finmark described in last year's report.[8] The deposit, which does not look promising, cannot be called a vein, nor even a fahlband, since the rock is not greatly impregnated with pyrite, and the gold

[8] Rep. Bur. Mines, 1895, p. 82.

bearing part seems hardly to differ from the adjoining rock. A shaft has been sunk upon it to a depth of eighteen feet. Two or three other deposits of the sort occur in the region, some with more quartz, and are said to pan well. Unfortunately specimens taken for assay were lost.

We met the stalwart pair of prospectors, Landon and Lahay, for the first time on Mud lake, though their names have been seen on many a blazed tree from one end of the gold region to the other.

Later finds on the Upper Manitou.

Since we were at the Manitou interesting finds of gold have been made by Mosher and Leullier and Gasse on a bay to the east of Upper Manitou, now called Mosher bay. Very rich gold specimens come from this part of the region, and the deposits are said to be large. A mile or two east of this bay granite is found.

ROUTE TO LAKE OF THE WOODS.

Crossing over to Lake of the Woods. — The Nestor of prospectors.

Having seen the most interesting points on the Manitou, I decided to make my way in as straight a course as possible across country to the Lake of the Woods. We turned south towards the narrow lower end of Manitou, meeting on the way Mr. Alexander Baker, a patriarchal old gentleman, the Nestor of the prospectors on Rainy Lake and its tributaries. He was in a bark canoe with another man as bow paddler, and told us that all winds were fair for him, since he always paddled with them. He had picked up an Ojibway dictionary lost by Patterson, one of our men, and after recovering the book we pushed on to Lower Manitou where a high sea made us uncomfortable. One hour's paddle below this wide lake expansion there are some interesting old pictographs on an overhanging rock on the west side of the channel. They have been made in red paint and rise seven or eight feet above the water. Some parts of the work have been overgrown with lichen, but most of the designs are easily seen. Indians and bears play the chief part, the pictures being generally enclosed in squares or circles. In one compartment there are hands and "X's" only, and in another two headless figures. Our Kodak picture unfortunately has turned out a failure.

Aboriginal pictographs.

MANITOU LAKE TO PIPESTONE LAKE.

Having reached a point near Peep bay on the lower reach of Manitou, we entered a small land-locked bay and made a short portage into a charming lakelet, rising three feet, and soon another short portage, with a rise of five feet into Grant lake, a long and tangled body of water. Crossing it we portaged into Sairey Gamp lake, rising about thirteen feet. Another portion with a rise of about nine feet brought us to lake Harris, a much larger body of water than any other of the chain. The shores thus far were all Huronian, but the northwestern side of lake Harris is Laurentian. The contact on this lake should be worth examining by prospectors. On this lake we had a paddle of six or seven miles before a portage became necessary, this time over a pitch of four feet into a small creek. After another short portage on the creek we entered Missus lake, the highest in the chain. It was a curious freak of the explorer who named these lakes, a lover of Dickens evi

Memorials of Chuzzlewit in a charming chain of waters.

From Missus lake to the Pipestone region.

dently, to give the fictitious Mrs. Harris two such beautiful lakes, one for her title and the other for her name. No more charming chain of waters could be found than this series of lakes and lakelets connected by waterfalls or short creeks, all bounded by forest covered rocky shores and filled with water clear as crystal, so that one can see the big jackfish and red tailed suckers glide ahead of the canoe or dodge aside to let it pass.

From the west end of Missus lake there is a sixteen-chain portage across the watershed into a small lake at about the same level, and then a portage of thirty-five chains following the rapid descent of a small stream, with a fall of about a hundred feet into a second little lake which sends a sluggish weed margined creek into Strawberry lake. The creek proved very bad, so that our canoes could be forced through it only with the hardest of labor. A portage of about a third of a mile led over a mossy, little used trail having the trees much too close together for comfort in carrying Peterboro' canoes into a wider part of the creek, which at length opened into Strawberry lake, a pretty sheet of water four miles long, wooded to the water's edge. This empties by a sluggish lily bordered stream, broken by a fifteen-chain portage, into Pipestone lake, the distance being about four miles and the fall fifteen feet. The water in the Pipestone chain of lakes is brownish and contrasts unfavorably with the colorless waters of the Manitou. The trip as a whole is a delightful one, no burnt timber, and a picturesque variety of lake and creek. There are ten portages altogether, most very short, but one half a mile in length and two or three others a quarter of a mile, none really bad.

The Pipestone region was visited and described in 1894,[9] and as no mines have been developed since then, though some promising prospects have been taken up, we made no delay on this lake.

PIPESTONE LAKE TO REGINA BAY.

On a seldom traversed route.

Our route from the Manitou was partly over ground which I had traversed in 1894, though none of the other members of the party had ever passed through this portion of the region. We had no difficulty in finding our way with the aid of Lawson's excellent map of the Rainy Lake district. From Pipestone lake west none of our party had ever been, the route being seldom traversed. A short creek flows into the northwest arm of Pipestone lake from Schist lake, the difference in level being only about a foot. Schist lake has clear water and is very pretty. A portage twenty-seven chains long leads over into Sand Hill lake, where no sandhills are to be found, though the portage crosses a stony moraine. There follows a small clear lake, after which the watershed is passed, the next lake sending its water ultimately into the Lake of the Woods, while Pipestone and its neighbors flow into Rainy lake.

Groves of Norway pine.

Two or three small lakes and creeks bring one to Boulder lake, the whole region consisting of curious agglomerates which will be mentioned in the petrographical report. Boulder lake is well named, one of the huge rock masses lying partly in the lake being at least twenty-five feet high. Red-

[9] Rep. Bur. Mines, 1894, pp. 60, 61.

-stemmed Norway pines occur in fine groves and the scenery is very picturesque on this small chain of lakes, the pines running as crests along bold rocky hills.

Boulder lake discharges into Crow lake, one of the most beautiful bodies of water I have ever seen. The fall from Sandy Hill lake to Crow lake is probably thirty-five or forty feet, and there are five portages to be crossed. The water of this lake is very clear and of a sea-green color most unusual in the lakes of the northwest. It presents great variety of shore line and islands, and there are a few hills rising two or three hundred feet above the water with richly wooded flanks and top, but usually a precipice of gray rock with a tumultuous heap of angular blocks at its base. Near the west end of the lake a brulé spoils the appearance of the southern shore however. The rocks on the main body of the lake wherever we landed are gray or greenish gray agglomerates, often sheared into a schistose structure. There are a number of quartz veins, but not of a very promising character. Crow lake is fourteen miles long from east to west, with a greatest width of something over four miles. From the west end Emm bay leads four miles northward. There are two ways out into the Lake of the Woods, one to the south over a somewhat long portage into Sabaskong bay, the other north through a chain of lakes into Regina bay. As we wished to visit the Regina mine we chose the northern route, which is, in any case, the shortest course for Rat Portage, our ultimate destination. There is a fishing station at the southern portage, the whitefish and pickerel taken being shipped by tug to Rat Portage, but we saw none of the fishing boats, perhaps because we kept to the north shore. The picturesque Crow lake.

On our way to Emm bay some points and islands were found to consist of a black picrite or olivine gabbro, sometimes forming very perfect columns like those of basalt; but this rare rock exists only as dikes in the prevalent agglomerates.

The outlet of the lake is singularly hidden, so that we were in doubt whether we were on the right course until suddenly we came upon a narrow channel and rapids. Three or four chains portage, with a fall of thirteen feet followed by a swift bit of river, take one into Cedar lake. Here the shores are of agglomerate made up of blocks sometimes two or three feet across, having perfectly sharp edges. We lost our way on this small lake, going northeast into a long bay instead of finding the somewhat masked exit of the river toward the left. There is a pretty fall of ten feet on Cedar river across the strike of the schist, for the agglomerates have here been sheared into a schistose structure. A second rapid interrupts navigation with a fall estimated at about five feet before we enter Flint lake, which has a similar four cornered shape to that of Cedar lake. At the north end of this lake the agglomerates are at an end, and green schist with massive eruptions shows itself. A tortuous canoe route down to Whitefish bay.

Scarcely even a swift current separates Flint lake from the next of the series, Sturgeon lake, which lies also in green schist broken by green eruptive rocks.

The course on Sturgeon lake continues for three miles in the northeasterly direction followed since leaving Crow lake, but the only map available

is very imperfect, so that we lost some time in following the tangled lake too far east on the foggy morning of August 5. At length, discovering our error, we retraced our steps and turned due west. A swift current flowing westwards between islands proved to us that at last we were on the right course, and in about two miles we reached a small rapid with a fall of perhaps two feet, which marked the beginning of Whitefish lake. We found agglomerate on an island near the east end of the lake, and green schist at the opposite end.

A portage of about a third of a mile leads across a stretch of level, fertile ground belonging to an Indian reserve. This land is evidently a terrace, consisting, as one can see at the west end of the portage, of stratified clay rising ten or fifteen feet above the water. The portage is a regularly made road, no doubt used for lumbering purposes. In fact dams and flumes are found at most of the rapids up to Crow lake, and roads around the obstruction, generally much longer than is necessary for portaging on a canoe expedition, so that we usually followed the flume or chose a short way for ourselves.

General features of the route.

As the last portage brought us to Regina bay, which is connected with the Lake of the Woods, a few words may be devoted to a general consideration of the route followed from lake Manitou.

The time required was a little over four days of almost continuous travel, and, including a Sunday spent on Pipestone lake, we were for more than five days without the sight of a human being outside our own party of four, evidence that the route is little traveled. Indians do not seem to frequent the region to any great extent, wigwam poles being rarely seen, and a garden only at one point, on a portage a mile or two east of Pipestone lake. Prospectors appear not to have visited the region west of Pipestone lake, but it is probable that the coarse agglomerates, i.e. masses of eruptive rock cemented by a later eruptive or by volcanic ash, are not very favorable to the formation of gold deposits. We saw quartz in irregular veins and patches on a timber limit near Boulder lake, and also on Crow lake, but neither of much promise. Our journey was somewhat hurried however, and our observations were chiefly made on portages.

A great disadvantage on the part of the route west of the watershed between Rainy lake and the Lake of the Woods is the lack of reliable maps, the only ones available being very imperfect except where timber limits or Indian reserves have made surveys necessary. It is probable however that before long the Geological Survey will cover this region with a sheet of their excellent maps.

LAKE OF THE WOODS REGION.

Regina bay.

Regina bay, as it may properly be called, is an arm of Whitefish bay, a long and greatly ramified easterly projection of the Lake of the Woods. Regina bay receives the pure bluish green waters of Whitefish lake, and in fact the whole chain of lakes tributary to Sturgeon lake, including such large bodies of water as Crow lake, lake Rowan and Deer lake; so that, unlike

many parts of the Lake of the Woods, it is beautifully clear and free from the floating scum of green algæ so widely found in August. Regina bay might almost be called Regina lake, so narrow is its outlet through Sioux narrows westward into the main body of Whitefish bay. It has also a sluggish, weed choked connection on the north by Reed narrows with Long bay, another branch of the much divided Lake of the Woods.

REGINA GOLD MINE.

For the first time since leaving Missus lake, not far west of Manitou, we come upon granite towards the east end of Regina bay, where a boss of greatly shattered reddish gray granite has pushed its way up through green Huronian rocks and carried with it large blocks of weathered diabase. In some places the rocks are greatly mixed, one predominating and then another. The granite sometimes sends narrow dikes into the green rock, or even forms a breccia of its broken fragments. The easterly granite mass on the south shore of the bay is not so wide as represented on Lawson's map of the Lake of the Woods, and is interrupted before one reaches the Regina mine, another eruption of granite occurring at the mine itself. An area of eruptive granite.

The buildings of the mine present a very civilized and attractive appearance to voyagers like ourselves coming suddenly upon them from an uninhabited wilderness. The large mill building has been whitewashed, making it very trim as seen from the water, while the fifty electric lights, two of them street lights, gleaming out from the hill side and reflected in the lake, suggest to the wanderer something quite metropolitan. The shaft house and mill are built together down a steep rocky slope close to the water; the boarding house, office and other buildings are a little to the west. Buildings of Regina mine.

The vein on which most work has been done runs nearly north and south, dipping below the lake towards the north. This half of the vein is a true fissure in a small boss of plagioclase granite, much of which has the greenish look of protogine. To the south the vein runs into altered diabase (trap) and veers toward the east. At this end there is schistose matter mixed with the quartz. A little east of the mine the granite ceases and various green rocks, including a typical diorite, come out to the shore. A peculiar feature of the vein is that its dip is to the west in the granite, but changes to the east in the greenstone. The contents of the vein vary greatly in their tenor of gold, a shoot of comparatively rich ore running through it, partly in the granite and partly in the altered diabase. For a short distance the vein has one wall of granite and the other of diabase, and is to that extent a contact deposit. Some dikes of micro-pegmatite break through the green rocks south of the main shaft, and it is evident that the region was one of important eruptions after Huronian times. Veins and workings.

There are several other veins on the property; one, the west vein, is in weathered diabase and has the look of a bedded vein, the quartz being interstratified with schist, sometimes dolomitic. This vein strikes 20° or 25° south of east. The shaft had not been sunk to any great depth on this vein, nor on No. 1 vein to the west of the main vein, at the time of our visit; but on

No. 3 vein a shaft had reached the depth of one hundred and sixty feet, besides an air shaft sunk thirty feet, a hundred and thirty feet of winzes and five hundred feet of drifting.

Character of the quartz. The quartz carries pyrite and other sulphides, including molybdenite, some calcite and a dark substance of uncertain nature that fouls the plates badly. Some handsome specimens of gold occur here and there in the ore. It is stated that 80 per cent. of the gold is free, but in a very fine condition, and hard to save on the plates.

The mill. The ten-stamp mill treats about twenty-five tons per day with seven inches discharge and sixteen hundred mesh screen.

The company. The mine is owned by the Regina (Canada) Gold Mine Company of London, England ; Lieut.-General Wilkinson (chairman) acting as managing director. In August Mr. J. Leechman was mining engineer and Mr. J. M. Jones mining captain. Fifty men were employed at that time, including the staff.

A trim little steamer with the uneuphonious name of the "Squaw" brings supplies, etc., from Rat Portage, making the voyage to and fro in a day. My thanks are due to Lieut.-General Wilkinson and Mr. Leechman for their courtesy when we visited the mine.

Mr. Leechman, manager of the mine, has kindly sent me a memo. as to the advance made since August, and this may be included here.

Extent of mine workings 31st Dec., 1896. "Main shaft 233 feet from collar ; second level (110 feet from collar of shaft), south 300 feet from south side of shaft; third level (185 feet from collar of shaft), south 116 feet and north 107 feet. The vein in the main shaft is now and has been for 30 feet the full width of the shaft, viz., 8 feet, and stands vertical. In the second level south the vein has held 5 feet wide for over 200 feet. In the third level south the vein averages 6 feet wide. Driving north at the third level at 40 feet from the shaft we struck a vein—to all appearance our main vein faulted. We have driven on this now 65 feet ; it has been payable throughout. The width of the vein averaged 3 feet. Work on our west vein has been discontinued for the winter after sinking 70 feet and driving 14 feet on the vein. In the main shaft the 'trap' was struck at the south end at a depth of 177 feet, and at the north end at 185 feet. At the contact the vein was small, but rapidly widened with the change in formation. A cyanide plant added. To our surface works have been added a cyanide plant, McArthur-Forrest process, for treatment of concentrates, with a capacity of 10 tons per month, and a similar plant for tailings of a capacity of 600 tons per month, both of which are now in operation."

Northward through Reed narrows to Rat Portage. As our supplies were running low we decided to go without delay to Rat Portage to refit. Owing to strong west winds, and a sea too heavy for safety in canoes, we did not go out into Whitefish bay by the Sioux Narrows, but took the northern route, passing the small Hudson's Bay Company's post. There is a small extent of gardening done by Indians on islands and the mainland near by. Indian corn was in tassel and looked well on August 6. Sand cliffs from twenty to forty feet high and banks of stratified silt or silty clay show themselves near the entrance to Reed narrows. The narrows are

scarcely navigable for canoes in low water, the route passing toward the east side of a wide marshy tract. Long bay is a club shaped body of water, the head directed eastwards. It is narrow and straight, affording fairly sheltered water for more than 12 miles, when it opens between low narrow points into Yellow Girl bay, which is wider and partly filled with islands. On one of the islands we found an Indian dancing place, where there were the frameworks of two or three hemispherical conjuring lodges, made of interlaced rods. Inside there were rows of painted wooden pins, two or three feet long, some thick and others thin, like small organ pipes, also bundles of small party colored rods lying on the ground. Slender strips with the upper end bent down supported a piece of tobacco or a feather. Outside of the lodges on each of the four sides there were crossed arches of twigs like the center hoop of a croquet ground. The uses of these appliances neither of our men could explain.

Indian dancing ground and conjuring lodges.

Without further delay we paddled northwesterly, taking shelter where possible behind islands to French narrows, and then northerly to the Devil's gap and Rat Portage, a distance in all of about twenty-four miles. There is so wide a sweep of sea at many points on the Lake of the Woods that canoeing in "Peterboro's" should be cautiously done. Rat Portage was reached just in advance of a threatening thunder storm on the evening of August 7.

THE SULTANA MINE.

At Rat Portage we were delayed by wet weather and difficulty in getting men who knew the lake until August 11. A half-breed whom I had engaged refused to go with us at the last moment unless we would make him a large advance of wages. Two lumbermen who had just come to town with a crowd of others to be paid off agreed to go in the morning, before their cheques were cashed, but were too drunk and happy to be of any service when we wanted to start an hour later. At length we arranged with Patterson, who had never been on the Lake of the Woods before, and so had been paid off, to come with us to Sultana island, trusting to get another man from Mr. T. R. Deacon, land surveyor, who was at work near the Sultana mine and would have finished in a day or two. A good guide is very necessary in visiting mining locations, unless one is willing to lose a large amount of time searching for veins and workings.

Preparations to revisit Sultana mine.

Leaving Patterson to follow in a canoe, Professor Willmott and I availed ourselves of Mr. Caldwell's kind invitation to go on his steam launch. I had visited the well known Sultana mine in previous years, but wished to see what advances had been made in this most prosperous of Ontario gold mines, and wished also to study more carefully than before the country rock with which the ore bodies are associated.

The so-called Sultana island, really a peninsula separated by a marsh from the mainland, lies six miles southeast of Rat Portage, and is a conspicuous object in going up or down the lake as a high mound of rock burnt almost completely bare by a succession of fires. The southwestern end of the island and much of the adjoining Quarry island, separated only by a narrow fjord-like channel, are mapped by Lawson as coarse granitoid gneiss of the Lauren-

A boss of gneiss in Huronian rocks, and its gold deposits.

tian, with green Huronian rocks all around. This boss of gneiss is about a mile long from northeast to southwest, including part of Quarry island, and half as wide. Both the gneiss and greenstone are cut by dikes of various kinds, but the petrographical character of this interesting group of rocks will be described in another part of this Report.

Gold.

Two gold deposits, differing greatly in kind, are found in this eruptive boss, that of the Sultana mine on the northwestern side, and that of the Ophir vein to the southwest. The latter, which appears to be a fissure vein in the gneiss, has produced great numbers of exceedingly rich specimens of coarsely nuggety gold, but owing to various causes has not been worked for some years and was never worked to any depth, so that no further mention of it will be required here.

Sultana and Crown Reef veins.

The vein which was worked first at the Sultana runs about north and south along the shore, and has been followed eighteen hundred feet. It was evidently lenticular, lying within the schistose margin of the gneiss area, not far from the contact with the Huronian, but distinctly within the boundaries of the gneiss. This lens has been mainly worked out, but almost by accident a second, lower and much larger ore body, was struck on which mining is now progressing. The real size and shape of this new deposit has not yet been com etely defined, though it has certainly a width of forty feet at some poin with some schistose rock matter here and there in the quartz. It is probable that this ore body also will turn out to be lens shaped. Near the southern end of the upper lens a curious fissure vein, the Crown Reef, turns off to the northeast and then to the east in a sinuous way, and there is a large body of quartz on the lake shore where the Crown Reef meets the upper lenticular vein. The two main ore bodies dip somewhat lakewards; the Crown Reef is nearly vertical.

Extent of workings at the mine.

On August 12 the shaft was down to the fourth level at two hundred and eighty feet; but it was intended to give up the first level, and to leave the second level where the ore is not as good as on the others, until the mill has been enlarged. Most work was being done on the third level, where the immense body of quartz referred to was being mined. On the fourth level a drift had been run ninety feet toward the large ore body. At that point the vein was about twelve feet wide. In all nearly a thousand feet of drifting had been done, and the ore had proved richer at the lower than at the higher levels. Three air drills were at work, two employed in sinking, etc., one being sufficient to supply the mill with quartz. The ore remains as before, grayish in color, quartzitic in look, with some schistose matter and sulphides associated with it. The gold is far from coarse, but many fragments of ore show specks of free gold.

Free-milling ore.

In treating the ore Mr. Caldwell estimates that 75 to 80 per cent. of the gold is extracted by free milling methods, and the gold runs from 800 to 900 fine.

The gold mill and its equipment.

The mining and milling are done very economically and efficiently. The mill has frequently been described, but may properly be referred to once more. It contains a Blake crusher and ten stamps with Tulloch automatic feeders, and

about twenty- our tons of ore are treated per day. The stamps weigh 850 lb., have a drop of eight inches, and fall eighty-five times per minute. The screens are forty mesh. There are two corrugated Frue vanners, and the concentrates amount to only one or at most two per cent , and run from $30 to $45 or $50 in gold per ton.

To treat the tailings a chlorination plant was being arranged, and on a later visit I found this plant running successfully. For completeness sake it may be described here, the information having been obtained chiefly from Mr. C. G. Rothwell, who had put up the plant and was then running it. A chlorination plant installed.

The roasting furnaces are arranged on the principle of the German *Fortschauflungsofen*, the sulphides being delivered at the cooler end of the horizontal brick furnace, and gradually shifted by long shovels, worked through openings along the sides, till the ore arrives at the hottest part of the furnace where it is roasted dead. There is a roasting capacity of six tons per day, this amount being reduced to about four and a half tons in the process. The oxides resulting from roasting the concentrates are then treated by barrel chlorination, the complete operation requiring about eight hours, four for chlorination, during which the huge barrels are kept revo ving, three hours for washing, and the rest of the time for charging, etc. The chlorine is generated from chloride of lime with sulphuric acid. After treatment the charge is run into settling tanks, the clear fluid run off and acted on by sulphur dioxide to remove any free chlorine remaining, and then hydrogen sulphide is introduced to precipitate the gold. The sulphide of gold is put through a filter press and then roasted to remove the sulphur. A first brick had been obtained from the chlorination plant at the time of my last visit, but the exact results were not yet known. Since then it is reported that the process is working very satisfactorily. As there were two years' concentrates on hand, there was material for the plant to run on for some time; but in general the work of chlorination need be carried on only a small part of the year to treat the annual supply of concentrates.

Besides the erection of a chlorination plant, several other changes had been made since the previous year. A large new boarding house with stone foundations was being built, and also a new sleeping camp to the north of the old camp, where the ground has been cleared to make a very pretty park on a small peninsula. The buildings are being removed to free the ground for an air shaft to the south of the main shaft. When the changes are complete the camp will present a very clean and pretty appearance, the only serious drawback to its beauty being the desolate rocks of the burnt district behind. Camp improvements.

On the average fifty men are employed about the mine, almost all being housed and boarded in the buildings mentioned. Employes of the mine.

Mr. Caldwell intends trebling the capacity of the mill before long, and he is certainly justified in doing so by the enormous body of quartz already in sight and the ease with which a much greater quantity o ore can be mined. It was a genuine surprise, and also a great satisfaction, to see how immensely the prospects of this pioneer mine have improved in the last year or two. The history of the mine contains many thrilling and romantic incidents which are Progress and prospects.

admirably told by Mr. Caldwell himself in conversation ; and it is to be hoped that he will some day give us an account of his varied trials and discouragements, which could be overcome only by indomitable perseverance and pluck, combined with rare business ability. That he is now splendidly rewarded for his past trials will be a source of pleasure to all who wish to see mining prosper in our Province. Mr. Caldwell states that rock containing $7 per ton, a half dollar's worth of gold being lost in the tailings, could be worked at a profit with a thirty-stamp mill, as things are now going at the Sultana.

Stratified and boulder clays of the location.

Stratified clay rises some twenty-five or thirty feet above the lake along the shore near the mine, and boulder clay appears at points above it, heaped against the ridge of Huronian greenstones to the north of the camp. The stratified clay forms excellent soil for a fine garden where various vegetables were thriving, including plenty of cucumbers now almost over-ripe. Near the garden was an enclosure where a two year old moose was kept, being fed on twigs and saplings.

I have to thank Mr. Caldwell for much kindness and hospitality during our most interesting examination of the mine and its surroundings.

THE PINE PORTAGE AND ROSSLAND LOCALITIES.

Before leaving the Sultana we obtained another man, Tom McDonald, who had been assisting Mr. Deacon in numerous surveys on and near the Lake of the Woods and knew the region well. He proved efficient and genial, so that our canoe work was greatly helped. We turned northeast into Pine Portage bay in order to see the Triumph and other properties between that point and Rossland, the next station east of Rat Portage on the Canadian Pacific. Mr. O. S. Morris was good enough to serve as guide to the region, thus saving us time and trouble. Most of the land in this section, along the confused contact of Laurentian and Huronian, has been taken up as mining locations, but except at a few points little work has been done.

Triumph mine.

We visited first the Triumph mine on 12 and adjoining locations. At one point a gray medium grained granite, or perhaps quartz diorite, contains veins with quartz of a marble-like look said to contain a satisfactory amount of gold. To the south of it altered diabase (trap or greenstone) contains quartz veins also, especially along shear planes. At the Triumph mine a shaft has been sunk fifty-five feet on a very irregular vein of quartz in shattered and greatly altered green diabase. Large quantities of sulphides are carried by the quartz and some free gold occurs. The quartz at the bottom of the shaft was three or four feet wide. How important this ore body will turn out to be can only be determined by mining, so confused and irregular is its outcrop at the surface. On a neighboring hill, which rises at the highest point two hundred and sixty feet above the lake, there are bedded veins said to carry some gold lying beside bands of felsite, or rather sericite schist, and near by there is a large body of quartz, perhaps fifty feet wide, containing iron and copper pyrites, but reputed to be low grade. Mr. Morris intended to mill a quantity of the Triumph ore, which was considered rich, in two Tremaine mills of two stamps each, erected near a small lake on the property, the mill

Foley Mine. On the lake front.

Foley Mine. Stable and camp houses.

catfish are ironically termed on the Lake of the Woods. The latter are thrown away, the fishermen having no use for lawyers, while the pickerel are the most valued, fetching a better price than whitefish.

George Heenan mine.

At the George Heenan mine we found nothing but a small shaft full of water near the shore, and a blacksmith shop and house farther up. The country rock is hard green Huronian. These two mines are about four miles from the nearest Laurentian contact.

The Pole road to Gold Hill.

Our camp was pitched for two or three days at the foot of Moore bay, while we visited the Golden Gate and other mines in the vicinity. A very interesting tramway, generally called the Pole road, leads inland about a mile and a half to the Gold Hill mine. Heavy poles have been used as rails, the large end of each being hollowed so that the small end of the next fits into it. The roadbed has been graded and corduroyed, giving a solid foundation with fairly gentle grades. The trucks have pulley shaped wheels, with hollow rims fitting the shape of the poles. It was used to take in heavy machinery, etc., from the wharf at the landing.

Gold Hill mill.

The geological relationships of the Gold Hill and Black Jack mines were briefly described in the Report for 1894,[12] and need no further mention. No work was going on at the Gold Hill mine, but the mill was hard at work on quartz from the Golden Gate, a new mine opened up under the management of Mr. Ahn. Mr. J. Sutherland was in charge of the mill, and gave me all the information he could regarding both mill and mine. There are ten stamps, two Frue vanners and two Cook amalgamators, the stamps weighing seven hundred and fifty pounds with a thirteen-inch drop. The mill is of the Colorado type and crushes six or eight tons in the day of eleven hours. A Forster's rock crusher, having a curious oscillating action, is in use, and is said to work well, though it got out of order while we were present.

Golden Gate mine.

The Golden Gate mine is about half a mile northeast of the Gold Hill, and is connected with the tramway of the latter mine by a good wagon road. The mine is on the slope of a steep hill just at the contact of green Huronian rock with Laurentian gneiss. Dikes of felsite or micro-granite cut both gneiss and greenstone, and there are a number of bedded veins in the greenstone more or less parallel to the dikes or mixed up with them. Owing to an accident which had happened to one of the men the morning we arrived no work was in progress at the mine and there was little to be seen. The accident turned out not to be serious when the injured man was taken to Rat Portage.

Winnipeg Consolidated mine.

We followed the road north to the Winnipeg Consolidated mine, now a melancholy ruin with the mill machinery rusting to pieces. There is at present little to be seen there beyond the decaying buildings.

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[12] Fourth Report Bureau of Mines, p. 68.

THE ROUTE TO CAMP BAY.

Turning southwards, we crossed the Pipestone portage and paddled up Andrew bay to have a look at the curious copper mine opened up there some years ago by Messrs. Whiting and Kendall. A tunnel was driven some seventy feet into the decayed schist just above the water's level. Owing to last summer's high water the floor of the tunnel was flooded, so that we could not examine it. On each side of the decomposed schist ordinary unweathered green Keewatin schist is seen, but the rock here has been shattered, perhaps by faulting, and circulating waters have probably caused the changes seen. There is no vein, but the wide band of rusty decomposed schist is charged with siderite, often changed to brown iron ore, some quartz, and a little malachite, azurite and native copper, the latter in crystals, the largest of which are less than a quarter of an inch in diameter, but exquisitely perfect and always twinned octahedra. The crystals are very unevenly distributed. This decayed material is said to run one and a half or two per cent. of copper. An assay made at the School of Science, Toronto, gave only a trace of copper, but the sample may not have been an average one.

Copper mine on Andrew bay.

Leaving Andrew bay we turned south, passing the two small islands that serve as corks to the narrow neck of Bottle bay, whence we had been told there was a portage into the Lake of the Woods. We could find no way out of the "bottle" however, and had to paddle back and then westwards round the promontories of the Eastern peninsula and through French narrows, thus adding six miles to our journey. The red porphyritic granite which pushes through the schist on each side of Bottle bay does not seem to have opened up fissures to be filled with gold quartz, as various other granite eruptions in this region have done.

Bottle bay.

Eight miles southeast of the narrows Yellow Girl bay is reached, the granite portals of Red Cliff bay being passed on the way. Here we turned north into the narrow fjord-like opening of Bear bay, where some locations have been taken up and a little work done. This bay skirts the edge of the largest granite area on this part of the Lake of the Woods, but lies mainly in the Huronian schist. On D145, at the eastern side of the swollen upper end of Bear bay, we found two small houses and a clearing. Granite and schist conglomerate here come in contact, and irregular veins and large masses of quartz occur. With the quartz are mixed iron and copper pyrites and some rock matter; part of the quartz is amethystine. A small shaft has been sunk here near the shore and another opening made a hundred yards further up on a mass of iron stained granite, more or less seamed with quartz. An assay of material taken from the dump showed only traces of gold. On the lower part of Bear bay also a little work has been done, the deposit being simply granite charged with sulphides and slightly seamed with quartz. Free gold is said to have been found at each end of the bay, but we saw no distinct body of ore at the southern end. Two varieties of granite come in contact here, one gneissoid and porphyritic, Laurentian looking; the other finer grained.

Locations on Bear bay.

Foley Mine. The Office, on shore of Shoal lake.

Foley Mine. Cook house, bunk house and assay office.

Foley Mine. Outcropping of ore near Bonanza vein.

Foley Mine. Outcropping of ore near North shaft.

Foley Mine. Tram road looking south from North shaft house, 4,000 feet from mill. (Winter scene.)

Foley Mine. Tram road looking south towards the mill. (Winter scene.)

Foley Mine. Power drill at work in 200-ft. level.

Foley Mine. North drift of 200-foot level, Bonanza shaft.

Foley Mine. After a blast in 150-foot level

Foley Gold Mill, 20 stamps.

Cross and Chapel on Mount McKay.

Overhanging Cliff, North Side of Mount McKay, near Fort William.

once managed by the ill-fated Mr. Torrance. There is a good boiler and suitable buildings, but the appliances are meagre, there being no vanners. It is said that in a previous run only $10 was saved out of an assay value of $25. If so the tailings, which were turned into the pond, should be worth re-working. This mine has been secured by Col. Engledue, who had before this managed the purchase of the Mikado mine for an English company.

Pine Portage mine.

We visited the Pine Portage mine, which was being worked in 1884,[10] but has long been idle, and there is at present not much to be seen. The shaft is full of water and the log buildings are beginning to fall into ruin. The mill contains ten stamps and two Frue vanners, no longer of value from the effects of rust and decay; and the whole surroundings in the narrow romantic stream valley suggest moldering antiquity rather than a mining camp only ten or twelve years old. The vein of white quartz, with some calcite and sulphides, is in massive looking greenstone, penetrated by some felsite dikes, no doubt connected with the coarse grained red granite which crops out a few rods away. This abandoned mine and some others in the Rat Portage region form very melancholy spectacles when contrasted with a busy, thriving mine like the Sultana, turning out its gold brick every week with perfect regularity. It is stated that the Pine Portage mine and several others no longer worked are really of value, their failure being due to mismanagement or lack of capital rather than the small size or poverty of the vein. If that be true some of them may yet be worked at a profit.[11]

King mine.

The King mine, 221P, is a new find near the Government road leading to the Pine Portage mine. A small shaft has been sunk on a hill side not far from a pretty little lake. The country rock is coarse red granite, the shaft being in quartz and sericite schist, along a sheared zone of granite. The quartz has a somewhat quartzitic look and contains much pyrite. The band of quartz and interbedded schist is six feet wide and strikes 30° east of north.

BIG STONE BAY LOCALITY.

Keewatin mine.

On August 15 we turned south through Big Stone bay to Moore bay so as to visit the Gold Hill and other mines. On our way we stopped at the Keewatin mine, near a fishing station on the north end of Hay island. This is another of the abandoned mines. Small bedded and gash veins occur in green schist near the fish house landing, and on a hill a little way inland. The quartz is white and contains a little black slaty rock, pyrite and slender radiating prisms of tourmaline. A shaft has been sunk on a bedded vein on top of the hill when a shaft or a drift at the foot of the steep slope would have developed the ore body much better. The shaft house and blacksmith shop are in ruins.

"Suckers and lawyers."

At the fish house we found the men, all Scandinavians, sorting a splendid catch of whitefish and pickerel with a few suckers and "lawyers," as channel

[10] Geol. Sur. Can. 1885, cc. pp. 141-3.

[11] It is stated that a controlling interest in the Pine Portage mine has been purchased by General Alger and Mr. Farwell of Detroit, and that operations will be resumed on it this year.

Leaving Bear bay we paddled four or five miles southeast through the upper end of Long bay to the Passage, a narrow channel leading south into Whitefish bay, which has three connections of a very roundabout sort with the main body of the Lake of the Woods. Whitefish bay is twenty-five miles long and in one place seven miles wide, and considering the narrowness of its outlets it might perhaps fairly be considered a separate lake. It is a most intricate body of water, with many islands and a number of ramifying subordinate bays, some of them, like Regina bay, of very respectable dimensions. There are several wide stretches of open water on Whitefish bay, giving a Peterboro' canoe with the usual low freeboard a dangerous sea in certain directions of the wind, as we had occasion to discover. As the west shore of the bay is mapped by Lawson as wholly Laurentian, while the Laurentian and Huronian come in contact at or near the eastern shore, we followed the latter in our course south. At Log bay not only do Laurentian and Huronian meet, but a boss of later granite breaks through both. Since the distinction between eruptive granite and the granitoid rocks of the so-called Laurentian is not always easy to draw, Professor Willmott and I decided to spend a few hours in examining the locality, though no locations have been taken up in the vicinity. We found that both gneiss and granite have an eruptive contact with the Huronian schist, but that the granite is the later eruptive; however the two rocks have enough in common to raise doubts whether the two classes can be separated with certainty. In fact the name Laurentian in its old significance as introduced by Sir William Logan does not apply to the rocks so named in our western gold region. It is intended to discuss this matter further in the stratigraphical and petrographical part of this Report.

Whitefish bay.

Laurentian and Huronian rocks on Log bay, with eruptive granite and gneiss.

The next halt was made to examine the southern shore of the Sioux narrows at the outlet of Regina bay. There are several masses of eruptive granite here, the largest a little west of the narrows, and two or three locations have been taken up. Just east of the narrows D205 has been secured by Mr. Burley Smith. Here, at the contact of a small granite mass with green schist, there is a large irregular body of quartz more or less mixed with schist, on which a pit ten or twelve feet deep has been sunk. This location is about two miles from the Regina mine.

Eruptive granite at Sioux narrows.

GOLD AT CAMP BAY.

After struggling against heavy head winds for twelve miles and picking the most sheltered ways behind the islands, we reached Camp bay rather late in the evening of August 20. The "camp" was out of sight until we entered a tiny inner bay, when we saw three tents and an unfinished log house reflected in the perfectly sheltered water. The lower ground of clay was overgrown with immensely tall thistles and wild sunflowers about the tents and a high bluff of rock rose to one side. Crushing down the rank growth we found it answer instead of brush for our bed, and enjoyed our thistly couch after a hard day's battle with winds and waves.

The camp.

Camp bay is one of the newest points for gold discovery on the Lake of the Woods and comparatively little work has yet been done, though the specimens obtained here have attracted considerable attention in Rat Portage

Discovery of gold.

Gold was first found here by those intelligent prospectors, Messrs. Wright and Girard, who still held a share in the majority of the fourteen locations laid out at the time of our visit. Both these gentlemen were in camp, and Mr. Wright was good enough to serve as guide, which was fortunate, since no one knows the region better than he.

An area of Huronian schists, cut by diabase and porphyry dikes.

Camp bay lies only two or three miles west of Crow lake, and the Huronian rocks which we found on that lake really extend west to Camp bay instead of being cut off by Laurentian as shown on the geological map. On this excursion with Mr. Wright we saw no granite nor gneiss, but various green schists broken by coarse dark green amphibolite, and sometimes also dark gray porphyrite with many white crystals of plagioclase felspar. The country is hilly, since the harder masses have resisted erosion better than the soft schist. A row of high hills stretches southeasterly and represents the continuation of a great dike of diabase which one sees cropping out on the cliffs on the canoe voyage south. We ascended this ridge at a point where it rises two hundred and thirty or forty feet above the bay, as determined by aneroid. The dike has here very steep walls and is a hundred yards wide. It is evidently a later eruption than the others seen in the region.

Gold bearing quartz in the dikes.

Through the green schist dikes of a pale gray or yellowish eruptive rock, like felsite but really a sheared quartz porphyry, have been erupted, and these dikes with accompanying deposits of quartz are the gold bearing rocks. On S56 such a dike with much quartz runs northeast and southwest, the whole dike being about twelve feet and the adjoining quartz in many places three feet wide. The quartz is white or yellowish or reddish, of a somewhat quartzitic look and contains much free gold, as there was no difficulty in seeing, when specimens were broken off. S56.

The same vein of porphyry (called quartzite by some prospectors) crops out on S57, showing good looking quartz with specks of free gold, but a drift-filled valley hides the vein between. S57.

Some sinking was being done on S75, on a dike of quartz porphyry associated with much quartz, the whole being six feet wide and striking 10° east of north. The country rock here also is green schist. The quartz carries some visible gold and pans well. Besides the sulphides and gold, the whiter quartz sometimes contains tiny red scales of native copper, which puzzled the prospectors who panned the rock until they were informed what the substance was. Native copper occurs at several other points in the Lake of the Woods region, and often associated with gold. S75.

Native copper associated with gold.

Another felsite or quartz porphyry dike with quartz on one side runs northeast and southwest on S73, and pans gold. S73.

Importance of proving the auriferous dikes

So far apparently all the gold-bearing veins found in the Camp bay region are of this nature ; and since similar auriferous dikes occur near Rat Portage, on the Manitou and at other points, it is of great importance to settle how

rich and permanent this class of deposits is. It is to be hoped that some of these properties will be developed enough during the coming year to decide the matter.

Owners of locations.

When we visited Camp bay all the properties were in the hands of three companies. Messrs. M. P. Wright, C. N. Stirling and Thomas Walsh held S56, 57, 71, 72, 77, 78 and 92 Messrs. George Girard, G. W. Colcleugh, George Drewry and James Savage owned S73, 75, 76 and 79. Messrs H. Patterson and S. Forneri owned S90, 91 and 93. None of these properties had more than shallow pits in the way of development, and much more work must be done before their real value can be considered settled.

GEOLOGY OF THE EAST SHORE OF WHITEFISH BAY AND LONG BAY.

Exploring the coast lines.

Being informed by Wright and Girard that the rest of the eastern shore of Whitefish bay was of Huronian, not Laurentian, and this was at least partially true of the eastern end of Long bay, it was decided to explore these coast lines somewhat thoroughly in order to make sure. Prof. Willmott had determined the previous day that typical gneiss crops out at Last point, four miles below Camp bay, but that Huronian rock shows along the shore between, and we now found that the whole shore to the north presented a narrow strip of gneiss showing prominently on projecting points, but replaced by Huronian rocks at the foot of the deeper bays. Short excursions inland proved that the green rock turned up in every case within a short distance of the shore except at Ells peninsula, where the granite is perhaps a mile wide. No doubt during Lawson's survey this part of the field work was somewhat rapidly done, and the gneiss or granite found on all the more prominent points gave the impression that the country to the rear was also Laurentian.

Headlands of Laurentian with a background of Huronian.

Snake bay.

As Mr. Girard had stated that a boss of granite mapped by Lawson near the lower end of Snake bay was not to be found, I decided to look over the ground carefully to see if he was correct, since the presence or absence of an area of granite is of great importance to a wide awake prospector. Whatever the reason for its name, Snake bay deserves the title on account of its serpentine course, for it is an extraordinarily tangled web of water even for this region. I was anxious to visit its extreme southern end in order to find whether Laurentian or Huronian rocks occupied the interior east of Ells peninsula, and so entered a reedy inlet hoping to be able to push in a quarter of a mile and then portage over to the end of the bay, but found this impossible. To reach the spot that I was within a half mile of, it was necessary to paddle through nearly nine miles of intricate channels. We found neither granite nor gneiss anywhere on its shores, but only Huronian rocks. On a large triangular island near the middle of the bay, and also on other islands, there is a singular porphyritic diorite which we took at first for a conglomerate, on account of the immense white crystals of felspar embedded in it, looking like pebbles of some foreign material.

D177.

Near the north end of Ells peninsula, and not far from the entrance to Snake bay, a location has been surveyed, D177. The coast is here as usual

Laurentian, but a little way to the east green schist occurs. On the shore of a small bay an opening has been made on an irregular deposit of rather good-looking quartz in the granite, but no distinct vein is to be seen.

Following another of Mr. Girard's suggestions, we next made our way through the Sioux narrows into Regina bay, and then over our old route by Reed narrows into the expanded eastern end of Long bay. Here we were met by a fierce driving rain and were thus delayed an hour or two, almost for the first time in the summer. There is some good soil and level land on the northeast shore of the marsh where we halted. When the rain ended we sallied out into the stormy bay, where the strong west wind made coasting difficult. At the east end of the bay there is a marshy tract near the mouth of Dryberry river, which drains the lake of the same name, and little rock can be seen. A small island near the mouth of the river consists of a rock quite Laurentian in look, but in reality a modified Huronian quartz porphyry, and the shore westwards to a small unnamed marshy bay is of much the same character. On this bay the rock is sheared porphyrite, and is the same for a quarter of a mile inland. West of this we found quartz porphyry and an agglomerate of the same nature.

Huronian areas north of Long bay.

To complete the examination we coasted the shores of Mist inlet, which ramifies for three or four miles inland and found near the mouth quartz porphyry, and to the northeast green Huronian schist. At the upper end of the inlet the rock is soft, slaty chloritic schist. A crew of men were busily at work cutting ties in this remote little bay, and the busy camp with its numerous tents and teams of horses hauling the tie timber to shore made a complete surprise. They told us that a vein of gold quartz had been found near by, but we did not see any of the ore. We found heavy brownish clay and a considerable stretch of good land at the head of the inlet.

The results of our work correspond to Mr. Girard's statement, that Huronian slates occur north of Long bay and around Dryberry lake. He states also that gold has been found between the two, near Dryberry lake. It is likely that the somewhat Laurentian-looking sheared quartz porphyry which lines the north shore of the bay has been taken for Laurentian proper during the geological survey. When the mapping was done there was no practical importance attaching to the exact line of contact of Laurentian and Huronian, but now that the gold deposits of the region are found to lie almost invariably near the edge of the Laurentian, or of masses of eruptive granite, it becomes of great importance to have the line of contact settled correctly.

Practical interest in determining the line of contact.

Having completed this rough survey we camped over Sunday near the mouth of Black river, on an Indian reserve. Here the Huronian schists are more normal than farther east. Violent winds had thrown down many trees, especially jack-pines, on a hill near by, the thin soil resting on rock planed smooth by glaciers affording only a poor foothold.

BACK TO RAT PORTAGE.

On our way back to Rat Portage a number of old locations on islands were visited, the first being on Bath island, a few miles west of Yellow Girl bay. Here most work has been done upon an east and west vein, said to have been

Bath island location.

traced some distance inland. It is about four feet wide at the shaft, which is twenty or twenty-five feet deep, and goes down nearly vertically between fairly good walls of very fissile green slate or phyllite. The quartz contains sulphides, and is said to carry free gold. There are other quartz deposits irregular in shape, and mixed with felspathic rock near by. Two small buildings have been put up. What soil there is seems good, and we found plentiful choke-cherries and a few wild plums.

Carbonaceous slate.

Professor Willmott visited a curious band of carbonaceous slate near the channel between Hay and Middle islands, and obtained specimens of the material. He found two narrow bands which could be traced for fifty feet, interbedded with fissile slate. The carbonaceous bands, which are black, porous and smear the fingers, have been described by Lawson in his report on the Lake of the Woods region. Analyses of specimens from other points in the region gave in one case 5.773 per cent., in another 7.47 per cent. of carbonaceous substance. As Lawson suggests, these carbonaceous schists have no practical value, though geologically very interesting.[13] They may be compared with the black carbonaceous slate associated with anthraxolite in Balfour township near Sudbury, which was found by Dr. Ellis of the School of Science, Toronto, to contain 6.8 per cent of carbon.

Middle island and island K157.

A considerable amount of work has been done on location 444P, near the north end of Middle island. Three good log houses have been put up and a shaft sunk, now full of water. The quartz on the dump is much mixed with a coarsely crystalline dolomitic mineral, which weathers brown and contains a large amount of pyrite and some galena. The country rock is a very fissile green quartzitic schist. Island K157, a short distance northwest of the former location, shows irregular gashes filled with quartz in a country rock somewhat like that of the larger island. The ore is handsome, being heavily charged with galena and zinc blende, but would probably require smelting.

Prof. Willmott returns home.

On August 25 we returned to Rat Portage, and Professor Willmott, who had been suffering severely from inflamed eyes, aggravated by the somewhat stormy weather encountered, decided to close his field work and visit Winnipeg for a day or two before returning to Toronto. Mr. Willmott had proved so genial and efficient that it was with much regret I saw his departure.

WEST SHOAL LAKE REGION.

Across Lake of the Woods to Shoal lake.

On August 26, with Patterson as cook and McDonald as guide, I set out for the Western Shoal lake, where the Mikado mine was attracting much attention. We were all three with our camp equipment and supplies stowed in one of the Peterboro' canoes, sinking it so low in the water that great care was necessary not to swamp while crossing open stretches of water. The weather was windy, but fortunately the route chosen by McDonald among the islands south of Rat Portage, through Welcome channel and along the narrow island-strewn Ptarmigan bay, was usually well sheltered.

[13] Geol. Sur. Rep. 188 p. 58 CC. and 150 CC.

We stopped to make some enquiries at the farm of Mr. James Anderson on Corkscrew island, and I was much interested in the old man's establishment. A dog and a cat are his only companions, and the nearest neighbor is some miles away, a bachelor like himself. There is a considerable acreage cleared and the land is excellent, but the owner can cultivate only part of it, since the work is all done by hand. In his trim garden we found potatoes, beans, tomatoes just beginning to show a tinge of ripeness, corn in tassels, and rather too thrifty looking tobacco, one plant of the latter reserved for seed being in handsome bloom. Everything looked well except his beets and turnips, which had suffered from flies. He finds his market among the prospectors and fishermen on the lake or at Rat Portage.

A pioneer farm on Corkscrew island.

We stopped also near the mouth of Echo bay to see Oliver Daunais' locations, M12, 13 and 14, where some development has been done. A shaft has been sunk fifty-five feet on what seem to be a series of small bedded veins in a greenish gray porphyritic country rock. There are also associated with the quartz a quartzitic looking rock and a band of felsite schist. The quartz contains few sulphides, but is mixed with a good deal of dolomite. In some cases the latter mineral contains a few specks of free gold, and I have to thank Mr. Park, M.E. of Rat Portage, for an excellent specimen of this auriferous dolomite. This is I believe the only locality on the Lake of the Woods where gold occurs in this association. The general appearance of the vein matter was not promising however.

Oliver Daunais' locations on Echo bay.

Going southwest through Echo bay, we find granite at the portage into Canoe lake and along its shores. Another portage leads west into an arm of Clytie bay, and here the contact of green schist and granite occurs, many dikes of the latter penetrating the Huronian rocks. South of Clytie bay a narrow entrance leads into Bag bay, on whose southern shores the Mikado mine is situated.

THE MIKADO MINE.

The ore deposit worked in this mine was found less than two years ago by an Indian, who informed Mr. Bunn of the Hudson's Bay Co. in Rat Portage. Mr. Bunn and Dr. Scovill took up the location, but were apparently somewhat doubtful of its value, since they disposed of the property to Colonel Engledue, representing an English company, for $25 000. The place was visited by Mr. Burwash and myself in the summer of 1895, and we were impressed with the promising character of the deposit;[14] but scarcely any work had been done at that time, and our examination was on that account unsatisfactory.

Discovery and sale of the Mikado.

An August 27, 1896, I found a great change in affairs. A considerable amount of clearing had been done, several buildings were going up, and a force of men was at work opening up the deposit. Mr Theo. Breidenbach, a graduate of the Berlin Mining School, is manager, and did all in his power to assist my work.

[14] Fifth Report Bureau of Mines, 1895, p. 50.

Geology of the country.

The geology of the country about the mine turns out to be somewhat different from that given on the geological map, the granite area being less extensive towards the southwest than was supposed. A narrow strip of granite shows near the mouth of the Mikado bay on the west side, and a small tongue of the same rock reaches westward across the vein, but only a few hundred feet from the south shore of the bay green altered diabase shows itself and continues all the way across the portage to Hell Diver bay on the south. Some small outcrops of granite or felsite are found in the Huronian rocks to the west of the mine. The vein runs north 35° west, and dips 70° to 75° to the northeast.

Character of the vein.

It has been stated that the Mikado is a contact vein between granite and greenstone, but this is true for only a few feet, so far as shown by the excavations made at the time of my visit. The vein turned out to be less regular than I had supposed the previous summer. The work done by August 28 was almost entirely within the granite, the southern extension into the diabase having been only slightly opened up. This part of the vein is much narrower than the part in the granite, and changes its direction. In the granite one finds a distinct foot wall on the west side, but the vein matter seems to push out irregularly towards the east, no defined wall being seen, so that the full width of the deposit could not be very satisfactorily estimated. Ore carrying free gold is found perhaps fifteen feet east of the foot wall. The quartz carries an unusual number of sulphides, including pyrite, chalcopyrite, galena, molybdenite and bismuthinite, the latter mineral having been found only at this mine in the Lake of the Woods district. Fine specimens of platy gold are frequently found in the quartz, and sometimes also in the altered granite east of the quartz proper. The leaves of gold are rather pale in color, and seem to have been deposited in narrow cracks and fissures. Native copper has been found here also. The granite varies much in character, some parts being dark reddish gray a few feet from the vein, while at the vein the rock is greenish (protogine) and has had its felspar largely changed to quartz, as in the greisen of certain tin mining regions.

Development work and mill test.

At the time of my visit an open trench was being cut along the top of the vein, the intention being to obtain in this way a few hundred tons of ore for treatment at the Rat Portage reduction works in order to test the real value of the property. If the test turned out to be satisfactory, a shaft was to be sunk vertically on the hanging wall side so as to strike the ore at a convenient distance below the surface. The ore was transported in flat boats towed by a small steamer belonging to Messrs. Whiting and Kendall; and during the earlier part of the season, when the high water in the Lake of the Woods almost abolished the short current at Ash rapids, where Shoal lake enters the larger body of water, there was no difficulty in taking full loads. As the water fell towards the close of the season the work of transportation became much slower and more difficult.

Before I left Rat Portage a first instalment of the ore was being treated at the Reduction Works with what promised to be very good results, large

quantities of amalgam showing on the plates. This first run of 297 tons of ore yielded 969 ounces of gold, of the fine gold value of $14,535, being an average of 3.26 ounces or $48.94 per ton.

The Mikado property consists of locations D147, 148 and 149, and is owned by the Mikado Gold Mining Co., Limited, of which Colonel Engledue is president and Mr. C. MacNichol secretary, its headquarters being in London, England. Twenty-seven men were employed when I was there, but it was intended, if the ore turned out well, to employ a larger number, complete the necessary buildings, sink a shaft to the depth of a hundred feet, put up a stamp mill and perhaps also a plant for treating the concentrates. Since then a steam hoisting plant has been ordered and arrangements made for putting up the mill. The company and its plans

Mr. Breidenbach has been kind enough to write me on February 12 that he has crosscut from the shaft at the sixty-foot level, finding first a mass of quartzite containing some bismuthinite, and from traces up to $8 worth of gold. At forty feet from the shaft the real vein was struck. It is not as wide as at the surface, and apparently more refractory. He had drifted fifteen feet towards the southeast, and a few feet towards the northwest. The hanging wall at this level is not distinct, quartz penetrating the country rock and *vice versa*, while the foot wall is very smooth, having a selvage of dry clay an inch and a half thick. He states that they are preparing to put up a twenty-stamp mill with good concentrating appliances, and also a bromo-cyanide plant which will be erected during the spring. Report of progress.

OTHER LOCATIONS OF THE REGION.

Rounding the point to the west of Mikado bay, as the portion of Bag bay near the mine may be called, there is a small but beautifully wooded island on which Mr. Whiting was at work clearing and burning the brush to expose a gold deposit from which he had obtained rich specimens. The vein seemed irregular, and cut across the green Huronian rock towards the north end of the island. While we were there a boat came rowing up to the island apparently intending to land and take possession, but seeing it occupied withdrew, and later in the day we saw the party at work surveying another island somewhat to the northeast. The island on which Mr. Whiting was beginning his work has since turned out very well and is, I believe, now called the Cornucopia mine. Cornucopia mine.

Leaving Bag bay I visited the Monte Cristo location, D158, on a small deep inlet of Shoal lake a mile northeast of the mouth of Clytie bay. Here a bedded vein, in places ten feet wide, runs east and west for at least five hundred feet. Scarcely any work appeared to have been done on the property, and the quartz had not a very promising look, being little charged with iron oxide or sulphides. Monte Cristo location.

Returning through Shoal Lake narrows, location 188P was visited. Here there is a large mass of quartz at the contact of an eruptive mass of granite with greenish gray schist. The granite is generally coarse and red, but is Location 188P.

cut by dikes of felsite or microgranite. The quartz deposit, not a fissure vein, dips about 80° to the northwest, the granite forming the hanging wall. Mixed with the quartz there are some black schist, a little pyrite and dolomite.

Features of Shoal lake.

The western Shoal lake is a beautiful body of water, presenting great variety of scenery, narrow bays with rugged shores, multitudinous islands in its northern part, and a wide expanse of open water toward the south. Like all other parts of the Lake of the Woods region, however, it lacks perfection in having no mountains to mirror in its waters. It is likely that this hitherto lonely lake, visited only by Indians or Scandinavians interested in the pickerel and whitefish drawn from its clear waters, will shortly lose some of its beauty, since a group of rich and very interesting mines are now being developed. No doubt fire will do its work, and in any case the clearings about the mines and the need for timber must injure the general effect.

Ash rapids.

We found Ash rapids, by which the water of Shoal lake is discharged into the Lake of the Woods, hardly even a swift current. Mr. Anderson, the hermit of Ptarmigan bay, states that the latter lake was six or eight feet above its lower water level during the summer, and higher than he had ever seen it before except once. Leaving Ash bay our route was the same as on the way out, and need not be further described. Rat Portage was reached on the evening of Saturday, August 29.

RAT PORTAGE NEIGHBORHOOD.

Scramble mine.

The Scramble mine, on lots 13 and 14 of Jaffray township, is easily reached from the town, and although it was described last year by Mr. Blue, who visited nearly all the mines near the Lake of the Woods on which work was being done,[15] a few words here may not be amiss. This deposit is an excellent example of a fahlband, though some quartz is enclosed between the laminæ of schist. The rock is mica schist, or mica chlorite schist, and the vein rock differs from the adjoining country mainly in being heavily impregnated with pyrites. As mentioned by Mr. Blue, in spite of its unpromising look a few ounces of this schist generally show a good tail of gold in the pan. This property was taken up by Messrs. Benson and Norman, and Mr. Herman, who was good enough to serve as guide, states that it was found by means of a divining rod brought from Sweden. He says that Mr. Andrew Benson has located several other rich deposits in the same way, one of them under twenty-six feet of drift! This should certainly be a most valuable rod.

Extent of the fahlband.

The fahlband runs northeast and southwest and has been traced, it is said, for several miles. It will be of great interest to see how this property turns out when developed. If it proves to contain gold in paying quantities, this band of pyritous schist, which is at some points twenty-seven feet wide, should make a mine of great importance, for it is likely to run to great depths.

[15] Fifth Rep. Bur. Mines, 1895, p. 186.

Mr. J. A Herman is also interested in the Sweden mine, which he states is of a similar character, but lies to the southeast, nearer Rossland. He thinks the latter is richer in gold, and certainly a specimen which he panned in my presence gave very good results. This mine has since been stocked in Winnipeg.

Sweden mine.

Mr. Benson was developing what is stated to be an extension of the Scramble mine some miles to the northeast on Black Sturgeon bay, not far from the Eldiver mine, but I had not time to visit the place.

Benson's location on Black Sturgeon bay.

While at Rat Portage the Reduction Works, under the charge of Mr. Ahn, were visited, but Mr. Ahn himself was absent in Toronto. Ore from the Mikado was being crushed and the mill was working fairly well, though there was some difficulty in saving all the sulphides with which the ore was highly charged. As the equipment of the Reduction Works has been described in the last volume of Reports of Bureau of Mines, it needs no further mention here.[16] This establishment should be of great assistance in determining the value of properties within reach of the Lake of the Woods.

Reduction Works at Rat Portage.

A little way from the mill is the floating island which caused a mild sensation during the past summer at Rat Portage, taking the place of the sea serpent of seaside watering places. The island, which is about four and a half acres in extent, belonged in a bay of Coney island opposite Rat Portage, but this year's high water lifted it so far off from its moorings that a high wind drifted it right across the harbor to the north shore near the railway. Here the thrifty city fathers had a boom stretched around it to prevent further wanderings. This movable bit of real estate is said to be twelve feet thick in the middle, but near the edges it thins out to about a foot. The support is of driftwood supplied by the mills, etc., in the harbor. On this foundation reeds and coarse grass with some bushes have taken root, giving the expanse quite the look of a bit of damp meadow. At most points the floating power is scarcely sufficient to support a man. I saw another such floating island on Snake bay, an arm of Whitefish bay, earlier in the summer, but it was of much smaller dimensions.

A floating island in Rat Portage bay.

The first meeting of the Ontario Mining Institute at Rat Portage took place on September 8, and proved on the whole very successful.

Ontario Mining Institute.

LAKE SUPERIOR REGION.

On the following day I began my return. Two or three days were spent in and near Fort William, obtaining some needed information. A portion of the time was used in a visit to Silver Islet, where the rear end of Thunder cape was ascended,—Mr. J. W. Cross, who is in charge of the Silver Islet plant, going along as guide. The succession of old beaches is very distinctly marked on the route taken during the ascent.

Silver Islet and Thunder cape.

[16] Report of Bureau of Mines, 1895, pp. 187-8.

The climb to the summit of this end of Thunder cape is a very steep one after leaving a lower tableland, which stands about three hundred feet above the lake and perhaps represents a higher beach. My aneroid readings made the summit at this end of the promontory only nine hundred and sixty feet above the lake; but some rounded points farther west rise considerably higher.

I found the geological structure of the mountain more complex than it is generally represented.

Inspiring mountain views.

The view from the top of Thunder cape is a most inspiring one, and well repays the time and labor required for the climb of about a thousand feet. The cape and McKay's mountain on the other side of Thunder bay with their nearly vertically walled tableland summits make very impressive parts of the scenery in this magnificent region; and the great terraces of well-rolled stones on their flanks at different levels up to three hundred or more feet above the present lake unfold a marvellous story of greater lakes than our present great ones. I have to thank Mr. Cross for showing me the best way of ascending the mountain. Though past middle age, he has retained the vigor of a mountain climber. Returning, he chose a more direct route down a terribly steep little ravine on the side of the elsewhere unscaleable cliffs.

Pays Plats and the country northward

I had intended stopping at Pays Plats on my way to the Empress mine in order to visit some deposits of native silver near the railway, and also some gold veins twenty miles to the north, reputed very extensive and interesting; but finding that there was no guide available who could take me to the gold deposit without loss of time, I gave up this expedition.

THE EMPRESS MINE.

Jackfish bay.

The Empress mine is situated about a mile and a half or two miles inland from the northern end of Jackfish bay, but the road as now chosen is about two and a half miles long. From Jackfish station on the Canadian Pacific a two-horsepower steam launch runs about five miles up the bay, passing through a narrows half way up, where the water ebbs and flows strangely, and at the end running a few hundred yards up a sluggish creek. The scenery on the way is beautiful.

Lake terraces.

Owing to the fact that the launch was out of order I was detained most of the afternoon of my arrival, but employed the time in examining the fine old beaches on the shore of a bay two or three miles to the east. These terraces are almost as interesting as those near Port Arthur.

Development work at the mine.

In my short stay at the Empress Mr. Peters, who is superintendent of the mine and mill, did his best to show me all that was possible in the time. I found that great changes had been worked since my visit the previous summer. Then only a little stripping had been done, and the Messrs. McKellar were just beginning operations. The mine had been worked chiefly as an open cut near the top of the hill on which the veins are exposed. The veins are five in number, giving a total width of about twenty feet of quartz. They are of a bedded character and extend possibly for miles, since

the quartz has been traced long distances with varying widths, at some points much wider than where the mine is located. Several locations have been taken up on extensions of the Empress vein.

Mr. Peters told me that five miners could keep the mill going at that time, but it was evident that the mine could not much longer be worked as an open cut.

The mill I found to be the most complete in operation in Ontario up to that time. It is a ten stamp mill from Fraser and Chalmers, with Brown hydraulic sizers giving pulp of three grades of fineness, eighty, sixty and forty mesh respectively, going to three separate vanners. Mr. Peters states that sixty-five to seventy per cent. of the gold is free milling, and that the concentrates vary in amount from one ton in ten of ore to one in fifteen. The sulphides contain much copper pyrites and some galena. A little native copper occurs, as in some mines on the Lake of the Woods. The mill treats about thirty tons of ore per day. The ore is not high in gold, but is worked with surprisingly little expense, and everything is arranged very conveniently. Water is obtained from small lakes on the hill above the mill with a head sufficient to give ninety-eight pounds pressure for mill and fire purposes. The ore is transported to the mill by a short gravity tramway, home-made wooden cars doing the work.

A well equipped gold mill.

Since my visit the Empress has been turned into a stock company in order to raise sufficient capital to work the property by regular mining, a tunnel being driven into the hill at a level a hundred and forty to two hundred feet below the present open workings. It is expected that this tunnel will reach ore after running about two hundred feet, and to cut all the veins will require to be four hundred and twenty-five feet long. The mouth of the tunnel is high enough to run the ore directly to the mill without elevating it, and as long as the mine can be worked from this level no pumping nor hoisting plant will be necessary, thus keeping mine expenses at a minimum.

Report of progress at the mine.

Mr. J. T. Horne, general manager of the company, has informed me, under date January 7, 1897, that the tunnel was then about two hundred feet in, and that ore would probably be struck in about fifty feet, when the mill, which had recently been shut down, would start again. Since then it has been reported in the papers that quartz had been reached in the tunnel in satisfactory amounts.

PLEISTOCENE DEPOSITS AT PENINSULA.

A day was spent in the neighborhood of Peninsula on the north shore of lake Superior, examining the Pleistocene deposits at the railway gravel pit a few miles to the east of the station. I had the good fortune to fall in with a congenial companion, Mr. Miller of the Smithsonian Institution, the well-known mammalogist, who had spent the summer trapping the smaller mammals, mice, voles, etc., along the north shore of the lake.

Studies in a gravel pit.

The gravel pit shows an immense face, where the steam shovel has been loading cars, suggesting in its rough stratification of sand and gravel the arrangement found in kames. It is probable however that these beds

Lake terraces.

were formed at the mouth of a river in glacial lake Warren. The highest terrace which we measured rises 378 feet above the lake, the general surface of the gravel region rising at one point twenty or thirty feet higher. As these terraces have not been measured and described by Lawson, it may not be amiss to give the results of my aneroid readings.

Highest point	409	feet above the lake.
Highest terrace	378	" "
Terrace	357	" "
"	130	" "
"	85	" "
"	67	" "
"	45	" "

The level of lake Superior may be taken at about 600 feet above the sea. The lower terraces are well formed storm beaches; the two highest ones do not show wave action.

Kettle holes,

A very interesting point was the discovery of two immense kettle holes on the edges of which the gravel pit was beginning to encroach. One of the kettles had been somewhat breached by the lake before the railroad was built. The first kettle visited we estimated to be 150 yards long by 75 wide, the longest diameter lying east and west Its walls have a uniform slope, the bottom being 225 feet above the lake, so that from the highest part of the rim the kettle has a depth of about 180 feet. The bottom is dry, no doubt because of the good drainage afforded by its walls of sand and gravel. Another kettle a short distance to the west is about a third of a mile in longest diameter, but less regularly shaped and shallower, its bottom being 260 feet above the lake. It seems likely that grounded icebergs on the shore of lake Warren have caused these kettles, the sand and gravel being deposited round them, leaving cavities when the ice melted. This implies of course that the water was cold enough to allow an iceberg to remain unmelted while a hundred and eighty feet of sand and gravel were being laid down. Glacial streams may have furnished the materials rapidly, the ice front being not far off.

and their probable origin.

Professor Lawson mentions a number of small kettle holes in a terrace of stratified sand at McKenzie Station, fourteen miles east of Port Arthur, and hesitates as to their cause, but queries whether the ice masses may not have been embedded in the deposit, remaining there until the terrace was cut before the climate became warm enough to thaw them and allow the enclosing materials to collapse.[17]

Trapping small mammals.

Mr. Miller set a number of traps in the boggy ground between the station of Peninsula and the harbor, on the runways of mice, and at other likely points, and secured a very fair bag of mice and moles on his next morning's round. The results of his summer's trapping on the north shore of lake Superior, combined with the sub-arctic character of many of the plants, have suggested to him that there is an island-like area of cold climate north of lake Superior, perhaps accounted for by the chill water of the great lake. White River, not far to the east, has the coldest weather reported from any station of our Meteorological service, thus bearing out the other evidence.

Suggestions of a sub-arctic climate on the north shore.

[17] Geol. Nat. Hist. Sur. Minn., 20th An. Rep. 1893, p. 264 5.

Sultana Mine in 1892. Panning for gold.

Sultana Mine in 1896. View in the fourth level, 300 ft.

Sultana Mine. Amalgamators cleaning plates

Sultana Mine. Chlorination plant

Sultana Mine. Chlorination plant.

Sultana Mine. View of furnaces, chlorination plant.

Sluice at the Swede Boys' placer mine, Upper Maniton lake.

The Mill at Triumph Gold Mine.

My own observations show that at Lac Seul, a degree and a half farther north, and five or six hundred feet higher above sea level, wild fruits ripen more than a month earlier than on the north shore of lake Superior.[18] This lake is however considerably west of Superior. It would be of interest to find what the climatic conditions are due north of lake Superior.

Comparison with

During railway construction times Peninsula with its large and well protected harbor was an important port, and since those days it has been made use of to a slight extent by fishermen. At present the row of houses along the east shore of the harbor is almost wholly deserted.

A considerable amount of a coarse grained reddish brown to dark violet colored rock has been quarried at various points on the shore and near the railway, and used for construction along the railway. It splits into blocks of large dimensions, and is a handsome, if rather somber, stone that could be shipped inexpensively to any point on the lakes. The rock has the aspect of a very coarse-grained diabase, but appears to be really an augite syenite, though time has not been available for its satisfactory study.

Building stone.

RESULTS OF THE SUMMER'S WORK.

In general one may say that during the year gold has been found more and more widely in our region, though rarely at any great distance from the contact of Huronian and Laurentian. Not only is the known auriferous area extending, but new discoveries are being made in some comparatively old portions of the district, e.g., near Rat Portage. The number of points where free gold has been discovered now reaches well up into the hundreds, perhaps into the thousands, and there is no reason to suppose that even the best known portion of the region has been completely explored.

Enlarging the area of goldland.

Practically all the ores found are largely free milling, and none of them are very refractory, though the rich and interesting Mikado mine shows a large amount of sulphides, and the ore may prove somewhat refractory in depth. We have no arsenide gold ores in Ontario except in one narrow band near Marmora, and even those ores will, it is hoped, be treated successfully by the bromo-cyanide process. Though on the average the sulphides carry less than 25 per cent. of the gold contents of our ores, several mining companies are putting up chlorination plants for the treatment of concentrates, and one such plant, that of the Sultana, is working successfully.

Free-milling character of the gold ores.

One mineral new for the Province has turned up at the Mikado mine, bismuthinite, the sulphide of bismuth; the only other mineralogical point of importance noted during the year is the finding of scales of native copper in the quartz of many of our gold mines: probably the processes which deposited the gold also set free the copper.

Bismuthinite and native copper in gold veins.

[18] Fifth Report Bureau of Mines, 1895, p. 85.

Mines producing gold.

We have still only one large producer of gold, the famous Sultana, whose prospects have immensely improved within the past year; but several others have begun to produce, and at least four or five may be expected to reach a dividend paying basis within the coming year.

Prospects of gold mining are steadily brightening.

No doubt a large majority of the locations taken up will prove of little or no value, and many disappointments will result, as in all other gold regions, but there is every reason to think that in the aggregate a great many paying mines will be developed in our wide goldfield within the next few years. What the ultimate development will reach it would be rash to prognosticate at present, for in reality the surface has only been scratched; but the prospects have steadily brightened during the past three years, and if no setback occurs such as over-booming with a consequent reaction, Ontario seems likely to take its place before long among the important gold producing countries of the world.

Any doubts as to the extent and permanence of at least a portion of our gold deposits have been completely dispelled by the results of the past year's development.

STRUCTURAL GEOLOGY OF THE GOLD AREA.

Summing up our knowledge of the geology of Ontario's gold area.

The gold area of Ontario is of an almost unique kind. In many respects no other gold region can be compared directly with it, and the laws governing its auriferous deposits should be worked out for themselves. On this account it will be useful to sum up our present knowledge of its geology. There is perhaps no other large gold region confined to rocks of so ancient an age as the Archæan; and something should therefore be said as to the arrangement of these rocks. In general the excellent work of Dr. Andrew C. Lawson, formerly of the Canadian Geological Survey, now of California University, may be accepted as laying the foundation of our knowledge both of the Lake of the Woods and the Rainy Lake districts. The general principles worked out by him for these parts of the region are found to apply also to the Seine river, Manitou and other more recently discovered districts.

Lawson's general principles of Lake of the Woods and Rainy lake regions.

As explained and mapped by Lawson, the region consists of Laurentian and Huronian rocks, the term Laurentian being used in a petrographical, not historical sense, and the probable Huronian being called Keewatin. A group of more or less modified sedimentary rocks, consisting of sandstones, mica schists and gneisses, Lawson names Couchiching and places beneath the Huronian; but as they are seldom or never gold bearing they require no further mention here.

Laurentian and Huronian rocks.

As a usual thing the so-called Laurentian rocks, consisting chiefly of granite, granite gneiss and syenite gneiss, form rounded areas half a mile to a number of miles in width; and enclosing them are great meshes of Keewatin (Huronian schists and eruptives, generally green in color and basic in character, but sometimes pale and siliceous. Lawson has proved that the granitoid rocks push up as eruptive masses through the schists, nipping in

the latter as synclinal folds with bedding having a steep dip away from the Laurentian. The Huronian rocks, are chiefly eruptive flows and metamorphosed volcanic ashes, but sometimes water-worn conglomerates. At the junction of Laurentian and Huronian there is generally a strip of greatly disturbed territory where the granite or gneiss has floated off small or large blocks of the green rocks, or has pushed dikes of granite or felsite into fissures of the Huronian. Eruptive bosses of a later granite in many places penetrate both Laurentian and Huronian, and likewise send dikes into the adjoining rock.

Eruptives.

This brief outline of the Archæan geology of the region will perhaps be sufficient as a groundwork in our present subject. It is evident from the sketch just given that the region was one of great disturbance during Archæan times, mountain building, earthquakes and volcanic eruptions having been active, not alone in causing the general geological relationships which we now find, but also in opening up innumerable fissures to be filled with quartz and other minerals by circulating heated waters, thus forming the present ore deposits.

Evidence of great disturbance in Archæan times,

At a much later age the region, mountainous at the close of the Archæan, was worn down to an approximate plain, disclosing on an ice-smoothed surface the complicated arrangement of rocks and veins now so interesting to the geologist and prospector.

and of subsequent denudation.

A more complete description of the geology may be found in the reports of the Geological Survey of Canada and in previous reports of the Bureau of Mines.[19]

CLASSIFICATION OF THE GOLD DEPOSITS.

There is a good deal of variety in the gold deposits of the Province, so that it will be desirable to discuss them under some regular classification, such as the following:

Variety in the deposits.

1. True Fissure Veins.
   a. in Granite and Gneiss.
   b. in Huronian Massive or Schistose rocks.
2. Bedded, Lenticular or Segregated veins.
   a. in Gneissoid rocks.
   b. in Huronian Schists.
3. Contact Deposits between Granite or Gneiss and Huronian rocks.
4. Fahlbands in Huronian Schists.
5. Dikes of Porphyry or Felsite with associated quartz, mainly in Huronian rocks.
6. Eruptive masses.
7. Placer deposits of Pleistocene age.

1. TRUE FISSURE VEINS.

True fissure veins are most commonly found in the areas of eruptive granite and form important gold deposits in many cases, having a continuity and uniformity not usually found in the other types. The best known examples are those of Shoal lake on Seine river, where an area of coarse

Their occurrence in massive rocks of the Shoal lake (Seine river) region,

19 Lake of the Woods, A. C. Lawson. Geol. Sur. Can., 1885. Part CC. Rainy Lake Region, 1887, part F. Fourth Rep. Bur. Mines, 1894, p. 45, etc.

granite six miles in length by one or two in breadth contains scores and perhaps hundreds of well defined veins running in various directions. The granite is of the green "protogine" variety, a very siliceous plagioclase or soda granite in which there is much sericite, and it pushes up through Huronian rocks that had been greatly disturbed in ages long previous to the eruption. On the southeast side of the granite there is a schist conglomerate containing boulders of a variety of rocks; on the northwest an area of white anorthosite, generally called gabbro. To the north green schist and diabase (trap) are found.

It is in this small area, discovered only about three years ago, that the rich veins of the Foley, Ferguson, Lucky Coon and other mines are now being developed, and it is probable that another year will see a respectable output of gold from at least two of this group of mines. The veins may be expected to go to great depths, though at present the deepest shaft is down not much more than two hundred feet.

in the Sawbill lake and Harold lake regions,

The Sawbill mine on the lake of the same name, the Hawk bay mine, and other locations in the upper Seine river region are illustrations of similar ore deposits, but in rock that has a gneissoid look and seems to belong to the older group generally classed as Laurentian; while some veins of the Harold lake mine are in greenish eruptive granite.

and in Lake of the Woods region.

In part the main vein of the Regina mine on the Lake of the Woods should be classed here, since it starts in altered granite; but it soon passes into green altered diabase of the Huronian. The rich vein of the Mikado has the same association, starting in the granite but running into altered diabase.

The Ophir vein on Sultana island, from which such showy specimens were obtained a few years ago, is in porphyritic gneiss, and the Crown reef of the Sultana cuts the edge of the same area of gneiss.

Fissure veins in Huron schists.

True fissure viens are much less common in the Huronian schists than in the granitoid rocks, as might be expected from their structure, which parts much more easily between the layers of schist than across them. Good examples are however to be found on the Crawford property, HP301, north of lake Manitou, where a well defined fissure vein three or four feet wide may be traced for a quarter of a mile or more across the strike of the schistose country rock, and a somewhat narrower one for a still greater distance.

Many of the fissure veins in the Huronian schists are narrow and very crooked and irregular, and they are often associated with larger bedded veins. In that case the narrow cross veins are generally much richer than the others. Examples of true fissure veins in talc schist, small but very rich, are to be found on JO13, north of Seine river, a few miles east of Shoal lake.

2. BEDDED OR LENTICULAR VEINS.

Occurrence of bedded veins n schistose rocks.

The next variety of ore deposits, variously called bedded, lenticular or segregated veins, belongs especially to schistose rocks, just as true fissure veins are chiefly confined to massive rocks. Bedded veins are interpolated

between the schists, and run parallel with their strike. They are generally lenticular in shape, and when a lens runs out another often replaces it a little to one side. Frequently several layers of schist are more or less parted, bands of quartz of varying thickness filling the spaces between, when the ore body may have quite ill defined limits; but in many cases the lenses have tolerably definite walls, though seldom so distinct as in the case of true fissure veins. Bedded veins are sometimes however very like fissure veins, and the two kinds are not to be looked upon as totally different in character, since both must have been at one time open fissures through which water circulated. But they are not usually so continuous horizontally and vertically as true fissure veins, and the quartz is more often quartzitic in look than in the other class.

An interesting example at the Sultana mine of a bedded vein in Laurentian gneiss.

The most interesting example of lenticular veins in our region is found at the Sultana mine, where a lens of considerable width was traced along shore for eighteen hundred feet, the country rock being a gray schist probably formed by the shearing of a mass of porphyritic gneiss as it pushed up through Huronian rocks, the latter now largely removed. When the upper lens was about worked out Mr. Caldwell was so fortunate as to strike another very much larger body of quartz, hundreds of feet long and at some points forty feet across, with a little schist included. This immense and rich ore body is probably a second, lower lens, though work enough has not yet been done to make its form certain. The ore here is of the quartzitic type.

Bedded veins in the Huronian rocks.

I am not aware of any other bedded vein in Laurentian gneiss on which mining has been done, but veins of this description in Huronian rocks are by all means the commonest form of gold deposit in Ontario. They vary greatly in size, shape and importance. Often one finds a great number of small crumpled stringers of quartz with schist between, the whole uniting at some point perhaps to larger quartz masses, but without any well marked walls An example of the kind is to be seen in the well known Little America mine, on a small island just south of the border in Minnesota. In other cases there are well defined bands of quartz with fairly good walls, and traceable even for miles. The Empress mine, near Jackfish bay, and the other locations on the same vein furnish a good illustration of this, and the once famous Huronian mine in Moss township is apparently on a similar vein. Many more or less promising ore deposits in the Little Turtle and Manitou regions have also the same character, some of them containing exceedingly rich quartz, though up to the present none of them have been sufficiently worked to show their true value; and the same may be said of many bedded veins on or near the Lake of the Woods.

Besides vein-like or lenticular ore bodies, quite irregular masses of quartz occur in both Laurentian and Huronian, and a number of them have been proved to carry gold. We may include them however with bedded veins with which they are frequently associated.

3. CONTACT DEPOSITS.

Of infrequent occurrence in Ontario.

Contact deposits, extensive and valuable in some mining regions, are comparatively infrequent in ours, and none thus far found have proved valuable as mines. There is an interesting occurrence of the sort on Shoal lake narrows, location 188P, where a large mass of quartz with pyrite and dolomite is interposed between a boss of coarse red granite and greenish gray Huronian schist. A very little work has been done here, not enough however to give much idea of the value of the property.

The Mikado and Regina veins are sometimes spoken of as contact deposits; but they cannot properly be so classed, since the vein does not lie to any appreciable extent between granite and Huronian rocks, but in each case cuts across the contact, being enclosed at one end in granite and at the other in diabase, both being more or less regular fissure veins.

All the varieties of ore bodies thus far mentioned have the same essential character, having been deposited by circulating water in fissures or cavities.

4. FAHLBANDS.

Regions of auriferous fahlbands.

Fahlbands, or bands of schist impregnated with pyrite and other sulphides, are not infrequent in the Huronian rocks of Ontario, and in some cases they have been proved to be auriferous. Frequently some quartz is embedded between the pyritous schists, forming a connecting link with certain bedded veins.

The best known of these deposits is one near Rossland, north of the Canadian Pacific at Rat Portage. This runs northeast and southwest, including the Scramble, Benson and other locations, is twenty-seven feet wide in places and, it is stated, has been traced several miles. The gold carried is very fine, and is easily shown by panning.

Fahlbands occur also in the Manitou and Little Turtle regions, and at some points are rich in gold. Up to the present however no such deposit has been worked sufficiently to prove it a valuable mine, but it is very likely that some of them will be thoroughly tested next summer. They are often large enough to be of great importance if they carry even $3 or $4 per ton of free milling gold.

5. DIKES OF PORPHYRY OR FELSITE.

Frequent occurrence near contacts of granite or gneiss with Huronian rocks.

Wherever granite or gneiss comes in contact with Huronian rocks in western Ontario it is customary to find dikes of a finer grained, porphyritic kind penetrating the schists, and sometimes also the granitic rock itself. In many cases these dikes are largely penetrated with seams and stringers of quartz, or have irregular masses of quartz between them and the country rock. The fissures now filled with quartz may have arisen from shrinkage of the dike rock while cooling, or the dike may have formed a line of weakness along which later fissures were made. The quartz thus associated with felsite or porphyry often carries gold. Examples of this are found near Rat Portage, at Camp bay and on the Manitou. Sometimes the dike rock itself

shows colors on panning. Many locations have been taken up on dikes, but it still remains to be seen whether they will form workable deposits on any large scale.

6. ERUPTIVE MASSES.

Very few eruptive bosses or masses have been shown to carry gold in our region, though in other countries they occasionally form valuable mines. The Treadwell mine in Alaska, for instance, works a mass of greatly metamorphosed granite and makes an excellent profit on rock averaging probably less than $3 per ton. The only locations of the kind in Ontario, so far as I am aware, are on Round lake near the Huronian mine. Here a considerably altered quartz porphyry contains iron and copper pyrities, a little fluor spar and other minerals, and has been found by Mr. Hille to assay from nothing up to $7 per ton. There are great possibilities in so vast a mass of gold-bearing rock, even if it should run very low in gold; but it has yet to be shown that any such rock mass will form a workable mine in Ontario.

The Treadwell mine an illustration of a gold bearing eruptive mass.

7. PLACER DEPOSITS.

Owing to the scouring effect of the glaciers of the Ice Age it is probable that no extensive placers will be found in Ontario, though a few local ones representing the postglacial wear and tear of rich veins may turn out to have a limited value. The only one which has been at all worked is that of the "Swede Boys," near the south end of Upper Manitou. Here there is no water-worn gravel, but only swamp mud with angular fragments of schist and quartz from the adjoining weathered hillside. This was worked for only a short time with most primitive appliances and yielded, it is said, only a few dollars worth of gold.

Cause of their rarity in Ontario.

GENERAL OBSERVATIONS.

It was generally held some years ago that gold and other metals were to be looked for in Ontario only in the Huronian, the Laurentian being considered barren. During the last three years however the views of both geologists and prospectors have been changing. It has been found that some of the most promising gold deposits occur either in granite, as at Shoal lake, or in gneiss, as on Sultana island; and further that both in granitoid rocks and the green Huronian schists the best veins or other ore deposits occur at or near the contact of the two kinds of rock. At first this was held true only of eruptive bosses of granite; but there is good evidence to show that the eruptive contact of gneiss areas is just as effective. Scarcely any promising mine is located more than a mile or two from such a contact, and several of the best are just at the contact. Prospectors are generally familiar with this relationship, and wherever there are geological maps you will find them carefully scanning the contact zones as shown on them.

Old views on the occurence of metals are undergoing change.

The best gold deposits are found in eruptive bosses of granite and gneiss, and near lines contact.

Regions of promise for the prospector wherever Huronian and Laurentian rocks meet.

There is no reason to suppose that the limits of our gold region have been reached. Traces of gold have been obtained within the last few weeks in assays of quartz obtained fifty or a hundred miles north of lake Wahnapitae, and wherever in the great tract towards Hudson bay Laurentian and Huronian meet gold may be looked for hopefully. It is probable too that Huronian areas will be found within the great Laurentian stretch shown on our old maps south of lake Nipissing. In fact the Hastings series of rocks in which the earliest finds of gold were made in Ontario should almost certainly be included in the Huronian, and there is no doubt that other areas occur. The rocks which enclose the gold bearing vein of the McGown mine near Parry Sound would be called Huronian in Western Ontario.

The so-called Hastings series.

Source of the gold deposits.

The source of the gold deposits in our rocks is not easy to determine. The fact that they almost all occur near the contact of granitoid eruptive rocks with the Huronian suggests that one or other of these rocks furnished the original supply of gold, probably by lateral secretion. In the case of small and rich lenses we cannot assume fissures reaching to great depths, so that the adjoining rocks must have contained the gold afterward concentrated in fissures opened by the pushing up of granite masses into the Huronian schists. Gold has frequently been found in the country rock immediately beside viens, but probably this has been deposited from the solutions circulating in the veins themselves.

The auriferous fahlbands of the Huronian may have been supplied with the metal in the beginning, or they may represent shear zones where the rocks have been so shattered as to allow solutions to percolate and deposit sulphides with gold. The eruptive masses carrying gold almost certainly brought the metal up with them from the depths where they originated.

It is very desirable that unchanged country rocks of our gold veins should be carefully studied and analysed on a large enough scale to determine the real source of the gold. The results might have considerable importance from the economic side, and would certainly be of much scientific interest.

LITHOLOGICAL AND STRATIGRAPICAL NOTES.

General nature of the work heretofore done.

The great complication of the Archæan rocks of Western Ontario make it impossible to give their relationship in detail on a small scale map such as the geological map of the Lake of the Woods, two miles to the inch, and still more so on the Rainy lake and other sheets covering four miles to the inch; nor could it be possible to trace all these details in a geological survey carried out rapidly with a small force over a large area, much of the time being necessarily devoted to topographical work as the foundation for geological coloring. It will therefore be no derogation from the really admirable work

done by the members of the Geological Survey, Dr. Lawson, Messrs. Smith, McInnis and others, to say that in many parts of Western Ontario there are points of great interest still to be worked out, and that some of these points have a direct importance on the economic side as showing the associations in which the more important gold deposits are found.

In this portion of the Report it is intended to take up especially the lithology of some of these points from the scientific rather than the economic side.

SULTANA ISLAND.

The great gold quartz lenses of the Sultana mine are found at the northwestern edge of an oval boss mapped by Lawson as Laurentian. The enclosing rock, mapped as Keewatin, is green, fine grained and not distinctly schistose. The boss of Laurentian consists in its central part of coarse-grained gray granite, with phenocrysts of orthoclase half an inch wide. Going westward toward the edge of the boss the granite slowly becomes schistose, showing distinct parallelism of structure, and the porphyritic felspars are rolled out into imperfect *augen* or lens-shaped portions. At the water's edge near the Crown Reef the coarse gray gneiss passes rapidly into fine grained dark gray gneiss of a very schistose kind, and then into very fine grained brown black mica schist with crumpled strips or lenses of quartz. The contact with the Huronian is not shown here. The large quartz lenses in which the mine is worked lie in this schistose edge of the boss. The quartz is generally quartzitic in appearance, and contains many thin sheets or thicker bands of the dark schist.

Characteristics of the enclosing rock and of the Laurentian boss at Sultana mine.

Going northeast of the Crown Reef, the porphyritic granite passes into a coarse grained granitoid rock of a darker gray color and not porphyritic. The latter rock sends arms into the Huronian, and occasionally forms a breccia with fragments of Huronian rock.

Many small dikes run out into the Huronian, some of an acid character and yellowish or whitish in color, others basic and dark green, gray or black, usually somewhat porphyritic. Some of the lighter colored dikes cross the dark gray granitic rock, but none were seen in the central porphyritic granite.

Under the microscope the porphyritic granite from the central part of the island is seen to consist of quartz, somewhat broken or with slightly undulatory extinction, microcline, often with micro-perthitic inclusions of albite, plagioclase (oligoclase) having narrow twinning and low angles of extinction from the twin plane, and brown biotite. The plagioclase often shows fairly well formed crystals. It is usually badly weathered. The porphyritic felspars are micro-perthitic microcline, and sometimes enclose small crystals of plagioclase. Of accessory minerals only titanite and apatite were noticed.

The central granite.

An analysis of this rock was made by Mr. R. M. Rosebrugh in the Chemical Laboratory of the School of Science, for which I here express my thanks. The results are as follows:

$Si O_2$	69.80	per cent.
$Al_2 O_3$	14.53	"
$Fe_2 O_3$	5.35	"
$Fe O$		"
$Mn O$	0.06	"
$Ca O$	3.17	"
$Mg O$	1.72	"
$K_2 O$	4.37	"
$Na_2 O$	2.87	"
$Ti O_2$	0.05	"
$P_2 O_5$	0.06	"

The analysis shows that the granite is of a rather basic type, as one would expect from the considerable amount of oligoclase present in it.

The schistose margin.

As one approaches the Crown Reef at the western margin of the boss, parallelism of the constituents of the porphyritic granite shows itself, and the signs of crushing and shearing grow intense. The quartz shows " mortar " structure, being crushed into fine particles enclosing larger fragments. The felspars are broken and portions shifted asunder, calcite sometimes serving as cement. The plagioclases are so completely weathered into a confused saussuritic mass that the twinning is almost lost, and the microcline becomes turbid and often filled with sericite. At the very edge the quartz is rolled out into streaks of crushed particles, the felspar largely changed into a mixture of sericite and brown mica, and calcite and sulphides appear in considerable quantities. At the extreme edge little is to be seen in thin sections but brown biotite in minute scales. It may be that the almost black mica schist at the edge represents a modified margin of the basic Huronian rock in contact with the granite boss.

Quartz mica diorite.

The dark gray granitic rock into which the porphyritic granite seems to pass toward the north before the green Huronian is reached proves under the microscope to be quartz mica diorite. The quartz was the last mineral to crystallize, is not present in large quantities, and commonly shows a pegmatitic intergrowth with plagioclase. No orthoclase was recognized, and the plagioclase, judging by the angle of extinction from twin planes, is rather basic labradorite. It commonly has a tendency to idiomorphy, and is crowded with dusty particles and short dashes. Brown biotite like that of the adjoining granite is the chief dark mineral. Some confused masses of epidote and chlorite may represent vanished augite. Magnetite and apatite occur as accessory minerals.

As this rock differs so greatly from the granite, showing few signs of strain and being rather basic, it should perhaps be looked on as forming a distinct eruption, though its edge towards the granite is indefinite, suggesting a transition. The fact that acid dikes penetrate this rock but have not been

seen in the granite, from which they probably originated, makes it probable that the granite was pushed up later than the diorite, probably in a plastic rather than liquid state.

Dikes of both acid and basic rock are common in the green Huronian adjoining the porphyritic granite and quartz diorite. The acid dikes vary from a few feet to a few inches in width, and sometimes form breccias containing sharp angled fragments of the green rock. They are pale greenish gray to flesh red in color and usually medium in grain. The two thin sections examined contain much quartz, somewhat broken or undulatory in extinction, a small amount of weathered microcline and a large quantity of oligoclase, much of it idiomorphic. The only dark minerals are a small quantity of biotite and chlorite. These rocks look like granite and should probably be called plagioclase granite, though closely related to the quartz diorites. Acid dike rocks.

The basic dikes are dark gray, almost black in color, and either porphyritic with a fine grained groundmass or closely like the quartz diorite previously described. A greenish gray dike rock in which the porphyritic plagioclases are of the same color as the groundmass is in structure a porphyritic gabbro. The felspars are often idiomorphic, both in the groundmass and as phenocrysts, are short, stout, and at times zonally built up, the larger ones being generally very complicatedly twinned. Extinction angles indicate bytownite as the felspar. A little diallage remains, surrounded with greenish ragged hornblende, but most of the augite has disappeared. A small quantity of brown biotite is seen, filled with rutile needles. Two other dikes have a speckled appearance from the white phenocrysts of plagioclase. The groundmass in these is micro-granitic, and consists of quartz, plagioclase and hornblende. The porphyritic crystals are well formed and are, partly at least, labradorite. In one of the dike rocks rounded composite masses of green hornblende probably represent porphyritic augite. These rocks should probably be named diorite porphyrite. Basic dike rocks.

The dark green fine grained Huronian rock adjoining the eruptive boss is evidently a greatly changed eruptive, showing no distinct schistose structure. It contains plagioclase, epidote and dull green confused hornblende. The lath-like forms of the still recognizable plagioclase and the presence of remnants of augite show that it is diabase. Huronian rock.

Half or three-quarters of a mile south of the Sultana mine is the Ophir, which appears to be on a fissure vein in the porphyritic granite. A small opening was made on this vein years ago, resulting in the finding of the richest nuggety quartz yet obtained in western Ontario. On the dump near the vein there is a brown-black fine grained biotite schist, very similar to that near the Crown Reef. This appears however to occur in the vein rather than as a wall rock. The Ophir mine.

The ore bodies of importance found on and near Sultana island include two fissure veins, the Ophir vein and the Crown Reef, and two lenses, the upper one on which the Sultana mine first worked and the immense lower ore body on which work is now being done. It is probable that the rich body Ore bodies of Sultana island.

of quartz said to have been discovered by the diamond drill under the bay near the Sultana is a continuation of the lower lens, though it may be a distinct lens. It will be noted that all these veins are in the schistose edge of the porphyritic granite. It may be imagined that the granite while still somewhat plastic, i.e. not yet cooled to the point of consolidation, pushed up through the Huronian rocks, more or less shattering them and dragging out

an l their probable origin.

its own margin into the present schistose form. Before the process was complete the sheared edge of the mass was solid enough to allow the formation of great cavities between the layers of gneiss and mica schist. Here the fluids of the now solid but still hot granite could circulate, depositing the auriferous quartz.

It seems likely that the dikes of granite and porphyry penetrated the Huronian diabase at an early stage, when portions of the interior of the granite magma were still fluid. No pegmatite dikes were found on Sultana island. Up to the present no gold bearing lenses have been found on the southern, southeastern or northeastern sides of the Sultana granite boss ; nor have similarly arranged ore bodies been found at the margin of other areas of so-called Laurentian. It would be surprising however if the example above described should turn out to be alone of its kind.

SECTION III.

THE STORY OF SILVER ISLET.

Silver Islet is a speck upon the map of lake Superior. It is part of a mining location of over 15,000 acres in land and water lots, or nearly 24 square miles, but as it existed thirty years ago its own area was only the seventh part of an acre. When the first discovery of silver was made upon it in the summer of 1868 this islet was a rugged rock of 80 or 90 feet diameter. In outline it was not unlike a human skull, rising at its highest point six or eight feet above the lake level, and showing only a few square yards of vegetation. Yet the mine upon this islet was for fifteen years one of the world's famous mines; it gave employment summer and winter to hundreds of men; and it yielded about 3,000,000 ounces fine silver that sold for $3,500,000. For thirteen years, as the result in part of a mischance, the mine and works have been closed down. The great engines which so long pulsated with life are idle and rusting; the shafts, drifts and stopes are filled with water; and the workshops, the houses and the strong breakwater are the prey of storms. On the mainland, too, the big mill with its once fine equipment of vanners and batteries of reducing stamps is fast becoming a ruin; while the town which stretches for a mile along the beach has for its sole occupant a hardy caretaker whose nearest neighbors are the citizens of Port Arthur and Fort William, twenty-five miles away, as the boats run around the horn of Thunder Cape.

Introduction to the Story.

The story of Silver Islet deserves to be told for its own sake, for it is full of scientific interest as well as of episode and adventure. But it is worth telling also for the instruction and encouragement it may afford to a new generation, with interests revived as to the mining possibilities of our Province, and especially as to a section of it which for a few years has been for some cause under a cloud. One may hesitate if asked to express a belief that in the so-called Animikie area on the north shore of lake Superior there are other veins of silver ore as large and rich as the Silver Islet one. Yet it would be an instance without parallel if Silver Islet mine was shown to be the only one with a great fortune in it in the wide region of country to which it belongs. I venture to express a hope that some day other mines not less famous will be discovered and opened up on the north shore. The chief purpose of this paper is to keep alive the interest of mining men in that locality, through the story of Silver Islet.

THE WOODS MINING LOCATION.

To begin the narrative, one has to go back half a century, when Ontario was Upper Canada, and Upper and Lower Canada were United Provinces.

The rules under which mineral lands could be taken up fifty years ago were in one or two respects more generous than they are now, although there was little chance for the poor prospector. They enabled the holder of an exploring license who claimed priority of discovery to take up a tract of two

Mineral lands regulations of fifty years ago.

by five miles, the length to be with the course of the mineral vein, and the price to be four shillings currency (80 cents) per acre. It was necessary that a scientific agent of the Government should have an opportunity to mark the boundaries of the limits, determine the direction of the boundary lines in the case of different courses of veins on adjoining locations, and examine the statements of exploration furnished by an applicant. Only the rich could afford to buy a location upon these terms. Yet some favors were denied even to the rich. They did not get the mines of gold and silver with the land, these being reserved to the Crown. Besides that, the party who applied for a disposable tract was required to make to the Crown Lands office an advance payment of £150 or $600 on the first instalment, to provide for the cost of survey and other contingencies, and the remainder in five yearly payments with interest. The $600 deposit money (which constituted part of the first instalment) entitled him to a ticket of location from the Commissioner; but that sum became forfeited to the Government and the land was offered for sale again in the event of his declining to carry out a purchase on the terms, or of his failing to make good the payment of the first instalment within a period of two years. He might be allowed however to assign his interest, if he was lucky enough to find a purchaser of it, although upon its face the ticket was "not transferable."

The Woods location taken up and transferred to the Montreal Mining Company.

Silver Islet is in what was known as the Woods location. On 4th November, 1845, Joseph Woods of the town of Chatham applied by petition for a mining location on the north shore of lake Superior, and he selected one upon the south side of the promontory of Thunder Cape. On 13th May, 1846, Mr. Papineau, Commissioner of Crown Lands, issued instructions to John McNaughton, P. L. S., to survey the limits of this and other locations on the shores and islands of the lake. "His Excellency the Governor General," the instructions read, "has been pleased to direct that W. E. Logan, Esq., the Provincial Geologist, proceed to lake Superior, accompanied by a provincial land surveyor, and a sufficient number of men, for the purpose of ascertaining the nature and quality of certain mineral veins containing metallic ores alleged to have been discovered on the British shores and islands of lake Superior by various parties holding exploring licenses from Government, and of markingout for the said parties mining locations five miles in length by two in breadth, the length to run as nearly as can conveniently be ascertained in the general direction of the mineral vein and the breadth at right angles thereto." Mr. McNaughton was appointed to accompany Mr. Logan on this service and to act under his direction in marking out such parts of the limits of the mining locations as he might judge to be necessary, and when the work was completed to deliver the plans and field books of surveys to Mr. Logan for transmission with his report to the Commissioner.

Ten locations in all were surveyed by Mr. McNaughton during the season, including those of Mamainse and Pointe aux Mines on the east shore of the lake, and in the following winter plans were prepared. The map of the Woods location was handed to Mr. Logan on 22nd January, 1847, who sent it next day to the Commissioner. The results of the examination made by Mr. Logan himself were presented to Lord Elgin, the Governor General, on

1st May of the same year. On 7th May the location was transferred by the Commissioner of Crown Lands to the Montreal Mining Company, they having by deed of assignment become the assignees of Mr. Woods' claim, and in the mining location ticket issued to them the following conditions among others are set forth: (1) In the event of neglect to commence and bona-fide carry on mining operations within the period of eighteen months from the date of the ticket, or to pay up any of the instalments of the purchase money as they became due, the trustees should be held to have forfeited the location, as well as the deposit money. (2 The price was four shillings per acre, one fifth to be paid down within two years, whereof the deposit money of £150 was to constitute a part, and the remainder in five equal annual instalments with interest. But the patent might be obtained if the whole amount were paid at any earlier period, and it was satisfactorily proved that the conditions as to working the mines had been fully complied with. Conditions of the grant.

The Company did not comply with any of the conditions; neither did the Government exact the penalty. Eighteen tracts had been assigned to it by the original applicants, and were explored by Forrest Shepherd in 1846; but instead of working the mines, and paying the instalments with interest as they became due, the Company persuaded the Government to accept 40 cents instead of 80 cents per acre, without interest, and it appears also without working conditions. Patents were issued in 1856 for sixteen of the eighteen locations, the aggregate area of which was 99,498 acres, and the price paid was $39,799. The patent for the Woods' location is dated 10th September, and it bears the signatures of Edmund Head as Governor-General, of Joseph Cauchon as Commissioner of Crown Lands, and of E. A. Meredith as Assistant Secretary. The boundaries are set forth according to McNaughton's survey, commencing at a point "on the northwest shore of lake Superior, in north latitude 48° 19′ 48″, and west longitude 89° 17′, by Captain Bayfield's chart," thence north 13° 30′ west astronomically 154 chains, "so as with the small islands in front of the lands herein described as shown on Mr. McNaughton's plan of survey of record in the Department of Crown Lands to include an area of ten square miles," thence north 76° 30′ east 400 chains, thence south 13° 30′ east 175 chains to the shore of the lake, and thence west along the water's edge to the place of beginning, "together with the islands in front thereof above described," etc., reserving right of free access to the shore for all vessels, and right of public roads over and across the lands, and reserving also to the Crown all mines of gold and silver. The terms of the grant are thus given in detail as they will serve to make clear the grossness of an attempt to invade the rights of the grantees fifteen years later, when development work was just beginning to show the great value of Silver Islet. Reservations by the Crown.

[1] The documents do not show when Mr. Woods parted with his interest in the location, but as in the spring of 1846 Prof. Forrest Shepherd was despatched to explore this and other tracts on the shores of lake Superior on behalf of the trustees of the Montreal Mining Company it would appear that the claim had been transferred to them at that time. Among the six trustees named in the location ticket are Sir George Simpson of the Hudson's Bay Company, Hon. George Moffatt and Hon. Peter McGill. The Company itself however was not incorporated until 28th July, 1847.

Reservations made void and royalties abandoned.

Perhaps it was because the patent had reserved to the Crown all the mines of gold and silver upon the location that no effort was made by the Company to work or even explore its property for twelve years after it had secured the grant from the Crown. That was good cause for doing nothing, unless the land was known to hold other ores or minerals. It is certain that the first attempt at systematic exploration was made in the summer of 1868, after the new Legislature of Ontario had passed an Act which gave to owners of all private lands in a mining division the right to mine for gold and silver on their own lands, subject to a royalty of two to ten per cent., as fixed from time to time by Order in Council. And owners of mineral lands were still further encouraged to explore and work their lands by an Act of the following year, which not only declared all royalties upon minerals and ores of every kind to be repealed and abandoned, but also made void all reservations of gold and silver mines in any patent already issued. The last of the serious checks and hindrances imposed by the Government upon mining enterprise were in this way removed; and as about the same time provision was made for levying a tax of two cents per acre on mineral lands, the owners of extensive tracts like the Montreal Mining Company became convinced that it did not pay to hold them in idleness.

GEOLOGY OF THE DISTRICT.

A region of great disturbance.

But before proceeding to relate what was done at the Woods' location I will first present a sketch of the geology of the district, to help in gaining a clearer idea of its mineral bearing character. It is a region in which great disturbances have taken place in the course of the earth's history, so that it is not surprising if variant and even opposing views have been formed on the relations of the formations to each other by a number of able men who during the last half contury have undertaken the study of them. Let us look at the record of the rocks as some of those men have seen it and read it.

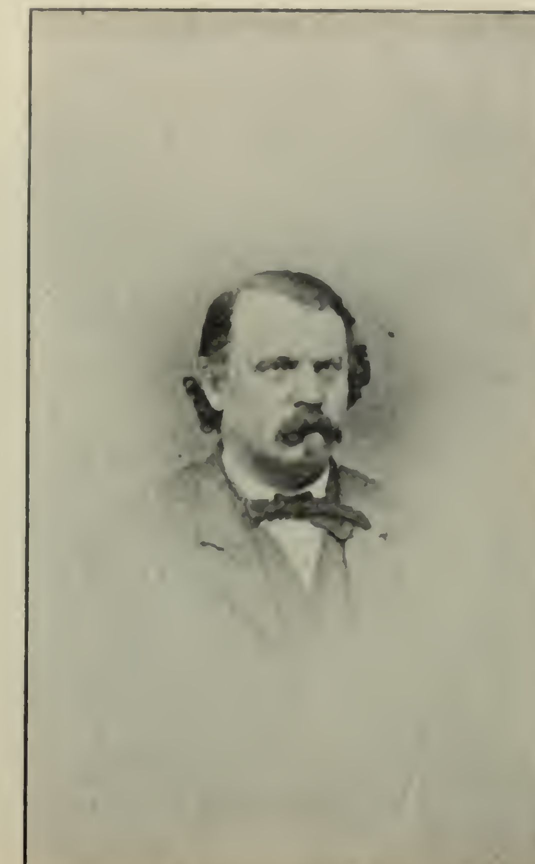
Forrest Shepherd's description.

The earliest report on the Woods' location is no doubt the one made by Forrest Shepherd to the trustees of the Montreal Mining Company under date of 27th November, 1846. The rocks of the southern portion of the location he describes as varieties of trap overlying slates, while those of the northern part are composed of stratified limestone and overlying sandstone. Upon the islands along the shore were seen large and well defined metallic veins, "highly charged with the mundic and gossan of the Cornish miners," and a prominent vein containing galena and green carbonate of copper was seen to cross a long narrow island near the mainland. Mr. Shepherd also made mention of a great dislocation "effected by the junction of the trap and sandstone," and suggested an examination of it as the possible repository of valuable ores.

SIR WILLIAM LOGAN'S EXPLORATION.

Logan made his first exploration of the region in the same year, and in his report published in May, 1847, he gives a general sketch of the geology of the north shore from Fort William to Sault Ste. Marie. Noting the hollow

Alexander H. Sibley.



Charles A. Trowbridge.

William B. Frue.

A typical miner of Silver Islet.

A view of Silver Islet from the mainland.

Another view of Silver Islet.

Silver Islet. Village on the mainland.

Silver Islet village, with officers' dwellings in the distance.

Silver Islet. Surprise lake, with Thunder cape in the distance.

Silver Islet. Surprise lake on the mainland.

Silver Islet. A view of Burnt Island.

Silver Islet. Ridges on mainland near the village.

in which the lake itself appears to lie, he observed that it presents formations of similar character on both the north and south sides, dipping to the centre. The series on the north shore he found to be made up of the following rocks: (1) Granite and syenite; (2) gneiss; (3) chloritic and partially talcose and conglomerate slates; (4) bluish slates or shales, interstratified with trap; and (5) sandstones, limestones, indurated marls and conglomerates. The three inferior groups of this series keep to the north of the Kaministiquia river from the neighborhood of the northern bend, which is at the Grand or Kakabeka falls, and maintaining a northeasterly strike come upon the shores of Thunder bay ten miles from the mouth of the stream. The slates are visible only a short way, but the granite touches the water at intervals for a distance of seven miles. Before reaching the head of the bay it leaves the coast, and a spur crosses the isthmus to Black bay at Granite islet, while the main range keeps several miles inland and turning in a more northerly direction reaches Nipigon river some distance above the second rapid. Upon the granites, gneisses and conglomerate slates, lying unconformably, are the two superior trappean formations, which Logan subsequently classified respectively as the lower and upper groups of the Upper Copper-bearing rocks of lake Superior. The lower one composes the whole country, mainland and islands, from Pigeon river to Fort William, the valley of the Kaministiquia below the falls being the boundary of its outcrop in that district. It constitutes the whole of the bed of Thunder bay, on the north side of which the conglomerate bed at its base is seen to rest in a nearly level position upon the highly tilted green slates. Eastward on the main front of the lake it makes up Pie island and the promontory of Thunder Cape, displaying in the latter a vertical thickness of 1,300 feet, and at a point six miles east of the cape a transverse dislocation lets down the succeeding formation at least 1,300 feet. The white sandstones at the base of this fifth formation form an escarpment on the southeast side of Thunder bay and are displayed in vertical cliffs rising to 200 feet above the water, which occupy about seven miles on the same side towards the northeastern extremity. The limestones and indurated marls start from a point about a mile and a half east of the downthrow, on the south side of the tongue of land separating Thunder and Black bays, and running parallel to the sandstones with a slight southeasterly dip they probably occupy the upper side of the last named bay. The base of the bluish slates where seen in contact with the underlying green slates is a conglomerate of quartz pebbles chiefly, with a few pebbles of red jasper and some of slate. Then follows a set of very regular layers of chert, varying in color from nearly white through different shades of gray to black, and varying in thickness from half an inch or less to six inches or more. Thin layers of a calcareous quality separate the plates from one another, and present a striking ribbon-like appearance. In the vicinity of the disturbed parts the chert sometimes passes into chalcedony and agate, "and small cracks are filled with small quantities of anthracite." This latter mineral has become more widely known to us during the past year as anthraxolite, a name given to it long ago by Prof. Chapman. Higher in the formation argillaceous slates are instratified with argillaceous sandstones in such an

Rocks of the north shore of lake Superior.

Upper Copper-bearing rocks.

altered condition that it is often difficult at first sight to say whether the latter may not be trap layers; and while sometimes exhibiting the structure called cone-in-cone, the harder bands show rounded concretions varying from a few inches to six feet in diameter. In some parts of the vertical thickness calcareous layers appear to be bedded with the slates, some of which are pure enough to be called limestone. Iron pyrites is scattered through the deposit, and often marks the cherty portion of it. "Trap bands conformable with the stratification are interstratified in several parts of the vertical amount," Logan says, "but they occur in greatest thickness towards the bottom, not far above the cherty beds, and at the summit overlying the whole formation. This trap has a distinct crystalline texture, and was in no instance that came under my observation of an amygdaloidal quality. . . . In all cases it presents a very striking sub-columnar structure at right angles to the plane of the stratification, and the crowning overflow gives a peculiar aspect to the whole region occupied by the formation to which it belongs. The overflow is from 200 to 300 feet thick, and the whole associated rocks to the base of the formation may possess a volume of between 1,500 and 2,000 feet." The fifth series has at its base a white sandstone, composed almost wholly of fine grains of quartz, but some of the beds show pebbles of quartz and jasper not exceeding the size of buckshot. Then follow interstratified bands of red and white sandstone, and a conglomerate of pebbles and boulders of coarse red jasper in a sand matrix, with some limestone and chert in the upper beds. Compact limestones with shales and sandstones are met with next in ascending order, and also some beds of indurated marls. "The sandstones and conglomerates become interstratified with trap layers, and an enormous amount of trap overflow crowns the formation"; but this refers more especially to areas east of the Woods location. "The trap taken as a whole," Logan says, "is a greenstone. It is in general of an amygdaloidal character, less so at the bottom than higher up; while at the top, in addition to the amygdaloid, there are met with extensive masses of a more solid and more highly crystalline quality, sometimes passing into well marked columnar basalt, exhibiting the forms of pitchstone-porphyry and pitchstone. The stratification of the amygdaloidal layers is usually well marked, and they do not in general appear to be individually so thick as the more solid and crystalline rock." All the formations down to the granite are traversed by a vast collection of dikes, yet Logan observed that in no one instance were any of the overlying or interstratified volcanic layers traced to a connection with the dikes of such a nature as to display to the eye that the one had its source in the other, and no dike of an amygdaloidal character was observed. "The number of these dikes was very great; thirteen of them of good size have been counted in the width of two miles, and their parallelism for great distances was as remarkable as their number." In one important respect too they have given character to the geographical features of the country, for being composed of much harder and more resisting material than the slates, sandstones and limestones, they serve the purpose of a natural mole or wall in protecting the softer and more yielding rocks from the force

Trap bands.

Sandstones and conglomerates east of the Woods location.

The formations traversed by dikes.

of the waves. "They sometimes run out into long prongs or promontories with deep recesses behind them, or present a succession of long narrow islands, which act as breakwaters in defending the neighboring mainland; and it frequently happens that a narrow breach having been effected in a dike, it will be found to be the entrance to a spacious cave worn out on each side in the softer rock behind it. In almost all these instances commodious harbors are the result, and it is mainly owing to the presence of these dikes that so many such harbors exist on the Canadian side of the lake." Naturally enough, where there are so many dikes, there are also mineral bearing veins, although Logan noted the fact that the fissures were of an age subsequent to the dikes. "A very large number of these," he stated in his report, "contain a greater or smaller amount of various metalliferous ores, and the indications which they present are such as to render it probable that some part of the country characterized by them will sooner or later rise into some importance as a mining region." The metals whose ores are most generally met with are copper, lead, zinc and silver, and nickel, cobalt, arsenic, uranium and molybdenum more rarely. Like the dikes, the veins were observed to be of two classes, one running with the stratification of the rocks and the other cutting it transversely. In the lower group of the Upper Copper bearing formation the most conspicuous system of veins, Logan says, consists of those transverse to the stratification. "They vary in breadth from a few inches up to twenty feet and more, and are in general composed of calcareous spar, heavy spar and amethystine quartz. Apophyllite is occasionally associated with heavy spar in some of the veins, and dark green saponite occurs more or less in almost all. Several of them are characterized by small quantities of vitreous, variegated and pyritous copper, iron pyrites, blende, galena, silver glance and native silver; and on Prince's location, to the west of Fort William, one of the lodes in addition to all these metalliferous products, including a promising quantity of the copper ore, holds cobalt and arsenic with a little gold. The veins coincident with the stratification, and cut by these transverse veins, are in general rather thin. They often run side by side with the dikes, and seem for the most part to consist of a breccia of the wall rocks, held together by carbonate of lime and quartz, while saponite is frequently present. Green and purple fluor spar are found in some of them, and prehnite associated with thomsonite occurs in others. The only metalliferous minerals observed accompanying them are iron and copper pyrites; but it is doubtful whether the quantity of the latter is sufficient to give promise of profit in working them. One vein coincident with the strike of the formation, which occurs on the northwest side of Thunder bay, appears however to be an exception. It is of great breadth, perhaps not under sixty feet, and in its general characters resembles the transverse veins; its earthy minerals being calcareous spar, amethystine quartz and heavy spar, while at the same time it carries small quantities of iron and copper pyrites, galena and blende."[2]

Mineral bearing veins.

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[2] Logan's Report of Progress for the year 1846-7, App. C., and Geology of Canada, 1863, chapter V.

Macfarlane on stratigraphical relations.

I cannot clearly make out whether Macfarlane agrees with Logan as to the stratigraphical relations of the rocks of Thunder Cape promontory and of the section of country eastward of it to Black bay; but evidently he was of opinion that the conglomerate bed and white sandstones which are described as succeeding in ascending order the gray argillaceous sandstones on the eastern part of the Woods location are unconformably overlaid by the hard crystalline rock which forms the summit of the promontory. "The summit rock of Thunder cape," he says, "is not a bed interstratified between the gray argillaceous and the white and red dolomite sandstones, but an overflow which has spread over both these groups after their deposition and partial disturbance." His study of the rocks belongs to the old school, being based on their chemical composition and specific gravity; for it is worth noting that at the time Mr. Macfarlane wrote his paper on the Geology and Silver Ore of the Woods location petrography was only just beginning to be made an exact science through the use of the microscope in the study of thin sections. But of course the order and relations of the rocks does not depend on their mineral composition, and Mr. Macfarlane did not seek to draw any such conclusion. His order, beginning with the lowest beds on the location, was: (1) Gray argillaceous sandstones and shales, evenly and regularly stratified, and contorted only in the neighborhood of the intersecting dikes, concerning which he says that in the vertical jointing and general lithological characters they much resemble the sandstones which occur to the north and south of Pointe aux Mines, on the east shore of the lake, and which there appear to overlie unconformably the traps and conglomerates of Mamainse. (2) Conglomerate of red colored and jasper-like quartzite, in a matrix of coarse-grained red sand. (3) White and dolomitic sandstones and shales. (4) Limestone, brecciated with cherty fragments. (5) Indurated marl, overlaid by white sandstone. The last named is on the eastern extremity of the location, and appears to be the highest in geological position upon the property. "These stratified rocks are intersected by numerous dikes of various thicknesses, running generally parallel with each other in a northeast and southwestern course. Their outcrops are most numerous in the western part of the location, where they and the enclosing argillaceous sandstones and shales have been so acted on by the waters of the lake as to expose plainly their mutual relations . . . Although the dikes are best exposed among the gray sandstones, many of them can be followed into the area occupied by the red and white sandstones, where they are found to intersect these also. They are always either vertical or inclined at high angles, the dip in the latter case being generally to the southeast, but sometimes also to the northwest. They vary in thickness from a few feet to nearly a hundred, and they sometimes exhibit interesting phenomena as to joints of separation." The numerous veins on the location are connected for the most part with the dikes which have been described. Some of these appear to be fillings up of separation joints in the rock of the dike; others run parallel with the dikes, and while of greater width it was not observed that they contained anything more valuable

Dikes and veins.

than specks of iron and copper pyrites; a third variety crosses the general course of the dikes, and is perhaps the most important of all. To this last class the vein of Silver Islet belongs. The dike itself is an intrusion of diorite at least a hundred feet wide running parallel with the shore at the distance of three-quarters of a mile,[3] and intersecting the sedimentary strata which in former times in all probability occupied the space between the islet and the mainland.[4]

Points of difference from Logan.

In at least two particulars Macfarlane seems to have differed from the stratigraphy of Logan, viz, as to the relation of the trap summit of Thunder Cape promontory to the sandstones and shales, and of these latter to the rocks at Mamainse. But this will be better understood with the help of the new nomenclature soon afterwards introduced. In the Geological Survey Report for 1872-3 Dr. Robert Bell proposed the name Nipigon for the Upper group of the Upper Copper-bearing rocks, and at the Boston meeting of the American Institute of Mining Engineers in 1873 Dr. Sterry Hunt proposed for the lower group the name Animikie. "The silver deposits of Thunder bay and its vicinity," he wrote, "including Silver Islet, are in veins traversing a series of dark colored argillites and sandstones, which are as yet known only in this region, and are overlaid in slight discordance by red and white sandstones, apparently the same with those of the Keweenaw district and the St. Mary's river. This older series of Thunder bay and its vicinity, which may be named the Animikie group from the Indian name of the bay, is the lower division of the Upper Copper-bearing series of Logan."[5] A few months later he suggested the name Nipigon for the red sandstones and marls of the upper group, while retaining the name Animikie for the lower[6], and five years afterwards in his volume on Azoic Rocks, written for the Second Geological Survey of Pennsylvania, he put the whole case in this way:

Bell and Hunt suggest new names for the Upper Copper-bearing rocks.

The Nipigon and Animikie formations.

"In the view of Logan the Upper Copper-bearing series consisted in ascending order of I, the Animikie group; II, the Nipigon group, as above restricted (neither of these being cupriferous); and III, the overlying cupriferous conglomerates and trappean rocks which we have named the Keweenian series. Macfarlane, on the other hand, regarded the Nipigon group as the equivalent of the horizontal sandstones which elsewhere in the lake overlie the Keweenian series. He had moreover previously noticed a series of bluish sandstones and slates, very unlike the red St. Mary's sandstones, overlying unconformably the basal beds of the Keweenian, where these rest upon the Laurentian near Pointe aux Mines, and subsequently pointed out the close correspondence in structure and in general lithological characters between these bluish overlying sandstones and the lower or Animikie group of Thunder bay. In accordance with these facts, the Animikie and Nipigon groups are

[3] The actual distance as shown on a plan made by Hugh Wilson, P.L.S., in 1872 is 60 chains, measured from the islet north 46° west to the mainland, across the west end of Burnt island.

[4] The Canadian Naturalist, new series, vol. IV., pp. 37-48 and 459-63.

[5] Transactions of the Am. Inst. M. E. vol. I., p. 339.

[6] Ibid, vol. II., p. 59.

by the writer regarded as belonging to two distinct series, both younger than the Keweenian." [7]

It appears to me that Hunt read more into Macfarlane than the papers of the latter warrant, but whether he did or not, there does not seem to be any doubt that he reached a wrong conclusion as to the age of the rocks, and that Logan was right. To any one who studies a section of the mainland at Silver Islet village, from the mill eastward to Sibley cove, it must be obvious that the sandstones and marls overlie the bluish shales of the Animikie, so distinctly marked by the presence of bombs or devil's pots along the beach at the western end.

Irving's observations.

Irving, who examined the locality carefully, was fully convinced of the later origin of the Nipigon or, as he prefers to call them, the Keweenawan rocks,[8] but he suspects that their lower place at the line of contact with the Animikie was due to an erosion intervening between the slates and the white sandstones, rather than to a great fault. That an erosion has actually taken place is quite obvious when one observes the scarp on the south side of Thunder Cape promontory, where a vertical thickness of 700 or 800 feet of Animikie strata are exposed, and the worn-down beds of the same formation at Silver Islet dike a mile out in the lake. But it is not at all unlikely that there was a dislocation also, of which there is good evidence. Irving had formed the opinion that the Animikie rocks consist of a great series of quartzites, quartz slates, clay slates, magnetic quartzites and sandstones, thin limestone beds and beds of a cherty and jaspery material, probably more than 10,000 feet in thickness, and that with these were associated in great volume and in both interbedded and intersecting masses several types of coarse gabbro and fine grained diabase, all of the types being well known in the Keweenian series. But it seemed very probable to him that "the original Huronian of lake Huron and the Animikie slates of Thunder bay, and thence southwestward to the Mississippi river, are one and the same formation."[9]

ORIGIN OF THE TRAP BEDS.

Earlier and later views on the origin of the trap beds.

It had been shown by Ingall, and also by Bell and Irving, that some of the sheets of trap in the Animikie rocks are intrusive; but the opinion expressed by nearly all the geologists who have studied the region down to the last four or five years, was that the igneous beds in the formation were volcanic flows, and contemporary in origin with the shales, sandstones, limestones, etc., with which they seem to be imbedded, like the formations of the overlying Keweenian series. Dr. Andrew C. Lawson was, I think, the first to show the real origin of those trap beds. In Bulletin No. 8 of the Minnesota Geological Survey, published in 1893, he laid down three propositions

[7] Second Geological Survey of Pennsylvania. Azoic Rocks, Part I., E pp. 240-1.

[8] "This seems plainly indicated by the exposures on the east side of Thunder bay, and thence to Black and Nipigon bays, but to any one approaching from the southwest along the Minnesota coast, becomes so absolutely certain as to admit of no question at all. Not only does one in descending the lower part of the Minnesota coast constantly cross the Keweenawan beds in descending order until the Animikie slates are reached at Grand Portage bay, but on the large island at the mouth of this bay he may see slates underlying Keweenawan diabase in a continuous cliff exposure." Copper-bearing Rocks of Lake Superior, by R. D. Irving, p. 385.

[9] Ibid, p. 390.

regarding them : (1) That there are no contemporaneous volcanic rocks in the Animikie group. (2) That none of the trap sheets associated with the Animikie, whether of the nature of caps or intercalated sheets, is a volcanic flow. (3) That these trap sheets are all intrusive in their origin, and are of the nature of laccolite sills. This conclusion might have been suspected long before from the observations of all the geologists on the character of the trap, for each one of them, beginning with Logan, had noted its crystalline texture and that in no instance was it of an amygdaloidal quality. Lawson sums up his argument that—

Dr. Lawson's propositions to establish that they are intrusive sills.

I. The trap sheets associated with the Animikie strata are not volcanic flows, because of the combination of the following facts :

1. They are simple geological units, not a series of overlapping sheets.
2. They are flat with uniform thickness over areas more than one hundred square miles in extent, and where inclined the dip is due essentially to faulting and tilting.
3. There are no pyroclastic rocks associated with them.
4. They are never glassy or amygdaloidal, and exhibit no flow structure, and they have no ropy or wrinkled surface or lava breccia associated with them.
5. They came in contact with the slates after the latter were hard and brittle and had acquired their cleavage, yet they never repose upon a surface which has been exposed to sub aerial weathering.

II. They are intrusive sills because of the combination of the following facts :

1. They are strictly analogous to the great dikes of the region in their general relations to adjacent rocks and in their field aspect, and in that both the upper and lower sides of the sheets have the facies of a dense aphanitic rock, which grades towards the middle into a coarsely crystalline rock.
2. They have a practically uniform thickness over large areas.
3. The columnar structure extends from lower to upper surface, as it does from wall to wall in the dikes.
4. They intersected the strata above and below them after the latter had been hard and brittle.
5. They may be observed in direct continuity with dikes, and only differ from them in being horizontal instead of vertical.
6. They pass from one horizon to another.
7. The bottom of the sedimentary strata above them, wherever it is observable, is a freshly ruptured surface.
8. Apophyses of the trap pass from the main sheet into the cracks of the slate above and below.
9. The trap sheets, particularly at the upper contact, hold included fragments of the overlying slates.
10. They locally alter the slates above and below them.

Lawson does not agree with either Irving or Ingall in their estimate of the great thickness of the Animikie rocks, one of whom puts it at 10,000 and the other at 12,000 feet. They did not, he says, recognize the tilted struc-

Thickness of the Animikie rocks.

ture or the great system of faults which are present in the group, and in his opinion one-fifth of the estimates is much nearer the true thickness. Yet he believes that the laccolitic character of the trap caps of the region implies an extensive erosion and removal of the once overlying strata, and it seems not improbable to him that over much of the Animikie area now capped with these thick sills there was not only a very considerable thickness of the upper portions of the Animikie, but that the Keweenian strata occupied the same area. He shows that the sills are not only of later age than the Animikie strata, but later than the Keweenian also, and intrusive in both. They have been injected along the bedding planes of the volcanic sheets of the Keweenian, just as they have been between the sedimentary planes of the Animikie. And because of this lateness of origin Lawson thought that these trap sheets required a distinctive name, and he has proposed to call them the Logan sills, which is quite fitting, for none of the geologists have done better work in the area of the north shore of Lake Superior than the eminent man who organized the Canadian Geological Survey. The chief interest the dikes and sills have for us in this connection however is the evidence they furnish of just such a period of rock disturbance as seems to be essential to the making of a mineral region, and there is hardly a doubt that they had much to do with it.

Evidence of erosion.

COASTAL TOPOGRAPHY OF THE NORTH SHORE.

Another piece of useful work done by Dr. Lawson refers to the coastal topography of the north shore. Logan had taken notice of the old sea beaches of lake Superior fifty years ago, and he made measurements in a rude way showing at least seven strands varying from 30 to 331 feet above the present level of the lake. Two years later Agassiz also noted them when making his tour of the lake, rising terrace above terrace in retreating sheltered bays or along protected shores, sometimes two or three within 20 to 50 feet of each other, and again extensive flat shores "spreading above to another abrupt bank, making the former shore, above which other and other terraces are seen ; six, ten, even fifteen such terraces may be distinguished on one spot, forming as it were the steps of a gigantic amphitheatre."[10]

Old sea beaches of lake Superior.

Lawson by careful instrumental levels has shown a succession of 32 or 33 strand lines, indicating definitely as many stages of level rising from 6 to as much as 587 if not to 607 feet above the level of the lake as it now is. All but the lowest of these, he points out, represent stages of a sheet of water which was very different in its general physiography from the present lake Superior. It is estimated to have had an area of about 150,000 square miles, and to have covered the entire region of lakes Huron and Michigan as well as Superior with several hundred feet of water, to which has been given the name of lake Warren. It would take me too far afield to discuss the question of the lowering of the lake waters to the level at which they now stand, but shortly it may be said to have been due to the crustal warpings in post-glacial times whereby the land north of lake Superior has been lifted

Lake Warren.

[10] Lake Superior by Louis Agassiz, pp. 413-4.

500 or 600 feet, while towards the south it may have subsided correspondingly. There is no doubt whatever as to the northern elevation, as post-glacial marine deposits have been found by Bell on Kenogami river 450 feet above the sea[11] and extending thence continuously to the shore of James bay, and his description of the pass from lake Superior to Long lake, the source of Kenogami river, goes to prove that it is the abandoned bed of a large river. Towards the south the great lake Warren may have had half a dozen or more successive outlets in course as the land subsided, before the channel of the St. Lawrence was opened to it, and if so the lowering of the water must have extended over a relatively long period of time. Lawson has traced an interesting series of beaches back from the village of Silver Islet along a trail to lake Marie Louise, which rises from the crest of the present storm beach 12 feet above the lake by gradual steps to a height of 168 feet; and at the back of Thunder cape, on the south side of the entrance to Sawyer's bay, he has given the record of a series of wave-cut terraces and sea-cliffs rising from 49½ to 392 feet, and possibly to 482 feet, although the last terrace is obscured by timber and could not be definitely recognized as of wave-wrought origin.[12] From the high level indicated by these terraces down to the line where the waters of lake Superior break over the crown of Silver Islet dike, there is a mighty interval; and while there is no certainty that the dike and the slates which enclose it did not rise much higher than they now are before the work of erosion began, one must cut loose the reins of fancy to conceive that there might have been a Silver Islet mine when the waves of lake Warren washed up the sand and peebles of the first beaches, or cut out strand lines in the solid rock.

Beaches on Silver Islet location.

DR. COLEMAN'S NOTES OF OBSERVATIONS.

For the latest notes on the geology of the Woods location I am indebted to Dr. Coleman, who besides the gift of seeing accurately has the trained mind to describe clearly and plainly.

Silver Islet itself, Dr. Coleman says, consists so far as one can see at present of Animikie slate crossed by a dike of quartz diabase, the latter greatly weathered. At the village on the adjoining mainland one finds dark gray slate of the same kind covered in parts with a sheet of diabase finer in grain than that of the islet and free from quartz. A path, used as a winter road for toboggans, leads a little west of north from the village across a col to Sawyer's bay. This depression between the hills seems to follow the course of a great fault which separates the mountain of Thunder Cape from

Islet and mainland.

[11] "Along the Missinaibi river, for many miles above its junction with the Mattagami, a blue clay, only occasionally holding pebbles, underlies the gray and drab boulder clay, which is overlaid by gravel, sand and gravelly earth. Marine shells were observed here and there along this river from the Grand rapid, and along the Missinaibi from near Round bay, all the way to Moose Factory. They appear in most cases to be derived from a pebbly, drab clay, associated with the boulder drift. Their greatest elevation above the sea on each river would be about 300 feet, but I have found them at a height of about 450 feet along the Kenogami river, a branch of the Albany." Dr. Robert Bell in Can. Geol. Sur. Report, 1875-6, p. 340.

[12] Sketch of the Coastal Topography of the North side of Lake Superior, with Special Reference to the Abandoned Strands of Lake Warren, by Andrew C. Lawson, in the twentieth Annual Report of the Natural History Survey of Minnesota, 1893.

The great fault across the mountain.

the high hills of the mainland to the east. Eastward of the trail Keweenian rocks rest upon the Animikie ; at the bottom coarse red conglomerate containing pebbles of quartz, quartzite and jasper or chalcedony with a calcareous cement ; above this gray quartzitic sandstone ; and on top rather soft red shale with some pebbly layers. West of the line of fault Dr. Coleman found gray slate up to the top of the first tableland, near the col between Silver Islet and Sawyer's bay ; but the surface is so covered with debris and vegetation that the upper edge of the slate could not be determined. At a level of 650 feet above the lake he found a thick bed of gray conglomerate composed of black chert and white quartz pebbles in a cement of coarse sandstone, and above this some sandstone or quartzite. Above 650 feet a cliff of diabase trap rises to 820 feet, followed by thick beds of gray sandstone reaching to 870 feet, above which a second bed of diabase coarser in grain than the lower one reaches the top. An aneroid reading made the summit at the east end of Thunder Cape range about 960 feet above the lake ; but the rounded summits to the west rise at least 100 or 200 feet higher. Descending the mountain at a point farther south, and with a much more precipitous slope, he found diabase down to 670 feet, then slaty rock with a few feet of sandstone and a band of conglomerate for ten or fifteen feet. Below this a talus of angular boulders hides the surface, but at a height of 450 or 460 feet slate appears again. From the summit of the mountain one can see that the red strata across the col, that is beyond the fault, have in places a decided dip toward the north. Several dikes of diabase and other eruptives penetrate the slate in the lower part of the valley, often standing up as walls or hill-like ridges. One of these not far from the village consists of a handsome diabase porphyrite containing large white crystals of plagioclase felspar in a dark green ground mass. This dike, which is said by Mr. Cross to have been followed several miles, contains at some points boulder-like masses of nearly white anorthosite or plagioclase rock. It is probable that the silver bearing vein of the islet is connected in some way with the fault, and the presence of dikes also points to times of great disturbance since the Animikie shales or slates were laid down. Dr. Coleman suggests that it would be well to map the district in detail and determine the amount of throw of the fault if possible. The continuation of the rich Silver Islet vein has been looked for with energy by men of all sorts, but never found, and he thinks that perhaps careful mapping of the country may give suggestions of value in this respect.[12]

The dikes in the slate.

DEVELOPMENT OF THE WOODS LOCATION.

Incentives to work.

We can now take up the story of mining work upon the location where it was broken off to introduce the geological sketch.

[12] This is quite possible. Indeed Mr. Cross, the caretaker of the property, is convinced that the vein which crosses Burnt island to the mainland is not the Silver Islet lead at all. "Off the point where the Catholic church stands," he informed me, "are to be seen two veins in the lake which I believe to be the true continuation of the Silver Islet veins. They carry blende and lead. and the gangue is the same, but no work has been done upon them beyond firing a few shots. This is about three-quarters of a mile north of Silver Islet. An outcropping has also been noticed just west of the end of Burnt island."

The removal of the royalties, the voiding of all reservations of mines of gold and silver in any patents already issued, the imposition of a tax of two cents per acre on mineral lands, and the recent discoveries of silver made by the McKellars at several points around Thunder bay were no doubt the chief causes which influenced the Montreal Mining Company to commence a systematic exploration of the lands held by them on lake Superior.

In May, 1868, an exploring party of six men, in charge of Thomas Macfarlane, arrived in Thunder bay, and after visiting the Shuniah or Duncan mine they started in a Mackinaw boat to examine the Jarvis location, one of the properties of the Montreal Company. It lies about 25 miles southwest of Fort William. Here they stayed from 20th May to 1st June, and then went on to Stewart's location at Pigeon river, returning to Fort William on 21st June Both locations were looked over carefully, but without any discovery of promise being made. On 23rd May they arrived at the Woods location and remained until 31st July. Here it was to be expected, Mr. Macfarlane says, that the junction of Logan's upper and lower groups of the Upper Copper-bearing rocks would occur, and that the many dikes and the trap of Thunder Cape would be found to present interesting relations to the sedimentary rocks. Therefore he determined to make a complete geological map of the location and arranged with his assistant, Mr. Gerald C. Brown, to survey the shore line. Exploration of the Montreal Company's properties.

While engaged planting pickets on the islands fronting the location Mr. Brown landed on the rock afterwards named by Mr. Macfarlane Silver Islet, and noticed a vein and galena occurring in it. Mr. Macfarlane himself then visited the island, and three men were set at work. The course of the vein was found to be N. 32° W., and its dip about 80 E. On the north side of the islet it had a width of 20 feet, but on the south it divided into two branches, each seven to eight feet wide. The gangue was seen to consist of calcspar and quartz, with galena in little cubes visible in every part of it, together with some iron and copper pyrites and blende. On 10th July the first metallic silver was noticed by John Morgan, one of the exploring party, in the shape of small nuggets on the east or hanging side of the west branch of the vein. A single blast was sufficient to detach all the vein rock carrying ore above the surface of the water, but the ore was traced some distance out into the lake where, instead of scattered nuggets of native silver, large patches of veinstone rich in galena were visible, intermixed with small particles and large nuggets of silver. The thickness of the rich part of the vein varied from a few inches to two feet, and by working in the water with crowbars some rich pieces of ore were broken off. On 15th July three packages of the best specimens were shipped from Fort William to Montreal, and altogether 1,336 lb. of ore was obtained which was carefully weighed and sampled in Montreal in the following December. Assays of four samples each were made by Prof. Chapman of Toronto, Dr. Hayes of Boston and Mr. Macfarlane, the average of which was 2,087 oz Troy per long ton. The rest of the season from 31st July to 23rd September was occupied in exploring other locations of the company east of Silver Islet. Next year work was Discovery of the Silver Islet vein. First workings on the vein.

resumed at the islet, but it was only upon the calmest days, when neither wind nor swell disturbed the lake, that operations could be carried on. The extreme coldness prevented the men from continuing for longer than half an hour at a time, yet they were enabled by working in a depth of two to four feet of water to raise and ship forty-six half barrels of good ore, weighing 9,455 lb. and valued by Mr. Macfarlane from assays made at $6,751. These figures seemed to justify an attempt to establish a mine on Silver Islet, and accordingly on 12th August a shaft was begun in the centre of it. Later on a shaft house was built over it, which contained sleeping and eating rooms for the men. A screen of two-inch planks protected it on the west side from the spray driven over the islet during heavy gales from that quarter, and at such times the men felt perfectly secure. The sinking of the shaft was continued until a depth of 18 feet was attained, or 12 feet below the level of the lake. At this depth several small veins were struck which brought with them more water than could be raised by a windlass, and the men were removed to the mainland to cut the timber required for the cribbing and other extensive works already planned for the next season. But although work in the shaft was discontinued it was found possible, owing to the formation of ice around the islet, to blast upon the vein under water and lift the ore out by means of tongs and long-handled shovels. In this way nearly nine tons were won and shipped to Montreal in the spring, and the report of the workings attracted much attention in England and the United States.

SALE TO THE ONTARIO MINERAL LANDS COMPANY.

Negotiations for sale of the company's locations.

The experience gained during the summer of 1869 had convinced Mr. Macfarlane that strong and extensive works would be necessary for the protection of the islet and the mine from the violence of the storms prevailing there. He estimated that at least $50,000 would be required for the purpose, and in the event of the company being unwilling to raise the necessary working capital he recommended efforts on the part of the board to sell the property. The total quantity of ore taken out up to this time was 28,073 lb., which realized after being smelted and sold $23,115. In spite of this bright showing, and of the fact that ten men in actual working time of fourteen days had been able to produce $16,000 worth of ore, the board decided to sell not only Silver Islet but the whole of its property of eighteen locations, aggregating 107,098 acres. Negotiations were carried on for this purpose during the spring and summer of 1870. The president of the company, Hon. Thomas Ryan, endeavored to procure the assistance of capitalists in London, but found little disposition there to "embark in distant mining enterprises." Other parties who had made a conditional offer for part of the lands failed to raise money in the same quarter. Finally, on 25th May, an agreement was entered into for the sale of the whole of the company's real estate to Edward Alexander Prentice, of Montreal, for $225,000, he putting up a forfeit of $2,000 and undertaking to pay $48,000 on 1st September, $50,000 on 1st January, 1871, $50,000 on 1st July and $75,000 on 1st September of the same year, with interest at six per cent. Mr. Prentice sought to place the

property in England and partially succeeded in negotiating a sale. Not being able to provide all the money required, the English parties in August telegraphed Alexander H. Sibley in New York, offering one-half the property on the terms of the bond. The proposal was accepted by Mr. Sibley, who went to Montreal, but on the day when the first instalment was to be paid over the English parties withdrew and left Mr. Sibley to find the whole amount or abandon the purchase. Mr. Prentice transferred his option to Mr. Sibley for a tenth interest, and having persuaded some American capitalists to join him Mr. Sibley became the purchaser of the whole of the Montreal company's property. The terms made with Prentice provided that in addition to the tenth interest he should be paid $1,000 out of the first earnings to reimburse legal and other expenses incurred by him, and that the sum of $2,000 which he had paid as forfeit money should be recouped to him. The title to the property remained vested in Mr. Sibley until 2nd November, 1870, when a deed of trust was executed wherein, after setting forth the conditions under which the business affairs should be carried on, the interests of the parties were made for the purpose of convenience on the basis of 1,600 parts or shares, as follows :

The locations transferred to an American syndicate.

Personnel of the new organization.

E. B. Ward	Detroit	440
Edward Learned	Pittsfield, Mass	400
Alexander H. Sibley	Detroit	100
Charles A. Trowbridge	New York	100
Peleg Hall	New York	100
William B. Frue	Houghton, Mich	100
William H. Zabriskie	New York	26
A. H. Sibley (trustee)	Detroit	154
George S. Coe	New York	20
Edward A. Prentice	Montreal	160

Messrs. Sibley, Ward, Learned, Hall and Trowbridge were named the trustees, with Mr. Sibley as president at a salary of $5,000 a year ;[13] and Mr. Frue became superintendent at the same salary, with a further understanding that he should be allowed $25,000 as a gratuity in case within one year the net proceeds of the mine should suffice to pay the purchase money and the gratuity. All that the shareholders put up was $50,000 to pay the first instalment and $23,100 for working capital. The balance of the purchase money was paid out of sales of silver, the product of the mine, which in the years 1870 and 1871 reached a total of nearly $800,000, and Mr. Frue earned and was paid his gratuity.

The official record of the company, which was incorporated by an Act of the Ontario Legislature in 1872 as The Ontario Mineral Lands Company, states that Captain Frue and a party of miners commenced work on the 2nd day of September, 1870, and a breakwater and dam were constructed which enabled him to begin mining in about thirty days. In November a heavy gale carried away part of this structure, which was repaired and work resumed, though under great difficulty, as boisterous weather prevailed most of the time during the winter. On 8th March, 1871, a heavy sea driving a

Official record of the new company's early operations—1870-1872.

13 At the same meeting of the trustees, held in New York city on 2nd November, 1870, Edward Learned was appointed treasurer and Charles A. Trowbridge secretary, with head offices at 52 Broadway, New York.

large body of ice carried away nearly half the cribwork and filled the mine and coffer dam with water. It was the 10th of May before mining was again resumed, and from that date until the end of the next year it was carried on uninterruptedly. Vexatious lawsuits which they had been compelled to sustain, intricate legal questions which they were compelled to compromise, and "insidious attacks upon the integrity of their property," which they had successfully defeated, are given as causes by the trustees which had rendered it inexpedient and impracticable to make a report of their operations until the close of 1872. But in the interval they had paid on purchase of the property, including interest and premium on gold, $247,209, for smelting and freight about $100,000, for labor and construction account about $260,000, and for various other services about $60,000, and in addition they divided among the shareholders $262,666 cash; and besides the $50,000 paid in by the shareholders for the first instalment of purchase money and $23,100 for working capital, they received from sales of silver $797,448 and from the sale of the Jarvis location $150,000.

Hindrances and successes.

"When the trustees took possession of the property," they state in the report to the shareholders, "it was a lonely and desolate wilderness. They have transformed it into a thriving and industrious settlement, with a church, schoolhouse, store, custom house, post office, and substantial dwellings for over 500 men. They have made it the best harbor of refuge on the northern shore of the lake, with a lighthouse on Silver Islet and range lights on the mainland, with extensive wharves for shipping ores and supplies, with basins protected by breakwaters, with a sectional dock fcr repairing vessels, with three steam tugs and complete equipments of all descriptions. Silver Islet itself was a bare rock, nearly a mile from the mainland, exposed to being daily submerged by the waters of the lake; measuring not more than eighty by one hundred feet[14]. Its area has now been enlarged to over two acres, well protected against storm and water, and covered with buildings for the mining, assorting and packing of the ore. The mine," they said, "is without question the most remarkable silver mine in the world."

Silver Islet Company organized.

But one important change had taken place during this time with respect to the Woods location. Deeming it for the best interests of the trusts, the trustees had on 21st February, 1872, made a deed of this location, including Silver Islet and the other islets in front of it, to a Company organized under the laws of the State of New York, and called The Silver Islet Mining Company of Silver Islet, Lake Superior. To this Company they conveyed all the mining plant and stores there and on the mainland, together with $60,000 or 60 per cent. of the capital stock of the Wyandotte Silver Smelting and

[14] Hardly any two authorities agree as to the exact size of the original islet. Mr. Macfarlane, writing in 1869, describes it as being at its highest part only six feet above the level of the lake, while in 1879 he says it was eight feet above the lake and measured about 90 feet each way. Captain Frue gave 70 feet as the greatest width and 80 feet as the greatest length, in no place rising more than eight feet above the lake. John H. Forster, who has written a history of the settlement of Silver Islet for the Michigan Pioneer and Historical Society (vol. XIV., 1889, pp. 197-205), says it was only 75 feet long by 60 wide, sloping from the apex to the water. James W. Cross, the caretaker of the property, who has been employed there since June, 1871, says the islet was originally 40 by 70 feet and rose at two points four feet above the level of the lake.

Refining Works, which the trustees had caused to be constructed for the purpose of smelting the ores from Silver Islet mine, there being no establishments in the Eastern States of sufficient capacity to do the work. It seems really to have been a company within a company, after the manner of the construction companies with which the finance methods of some great railway enterprises have made us familiar.

ATTEMPT TO JUMP THE LOCATION.

Reference was made in the report of the trustees to the insidious attacks upon the integrity of the Company's property, and before entering upon a fuller description of mining operations an account of this business may be given. I stick closely to the facts as they are found in the letters and papers on the subject in the Crown Lands office.

The new Company and its rights in the location.

The grant of the Woods location was, with the small islands in front of the tract on the mainland as shown by McNaughton's plan of survey, to include an area of ten square miles, or 6,400 acres. It was transferred to the Sibley syndicate by the Montreal Mining Company on 1st September, 1870, and on the same day Captain Frue arrived to begin work upon it. Furthermore, it appears that a license was procured by Frue from the Government covering 170 feet on the course of the vein on 20th June, 1870, which was renewed the following year; and according to a statement in a lengthy letter to the Commissioner of Crown Lands, under date of March, 1872, the Montreal Mining Company in the fall of 1870, "while we held a contract of purchase from them and with our concurrence for our benefit," applied for a grant of certain land covered with water appurtenant to the Woods location; but if this application was made it is not among the papers. Before the end of November, 1870, 287 barrels of ore, weighing 78 short tons and valued at over $100,000, was shipped to the Balbach smelting works in New Jersey, and at the close of the year the superintendent reported $60,000 to $70,000 worth of ore at the mine.[15] Operations were actively carried on at the islet during the whole of 1871, and this was well and generally known. Yet on 6th September in that year one Alfred Seymour of Toronto, afterwards of London, Eng., applied to the Department of Crown Lands to purchase several islands in front of the Woods location, Shangoinah island and Silver Islet and the land under water, but excluding Burnt island, being in all about 400 acres, and he paid in the money therefor at the rate of $1 an acre. The area, as shown by the plan filed with the application, embraced not only Silver Islet and the works upon it, but also the wharves and warehouses built by the Sibley syndicate on the mainland, together with the right of mining in any direction from Shangoinah island to the distance of forty chains beyond the limits thereof, and of building cribwork or other structures for the purpose of mining on any part of the location. On 5th October the application was submitted by the Commissioner of Crown Lands to the Attorney-General for an opinion: (1) Whether the "small islands in front" described in the patent of the Woods location included all or only some of them; and (2)

Alfred Seymour's application to the Crown Lands Department for islands and water lots.

Questions for consideration.

[15] Prospectus of the Silver Islet Company, February, 1871, pp. 6-7.

whether the land covered with the waters of the lake is within the authority of the Ontario Government to convey. It appeared to the Commissioner that only some of the islands represented on McNaughton's plan were shown, and on comparing the field notes with the map attached to the report of the Company's engineer, the opinion was expressed that Silver Islet and some other islands were not shown on the field notes. But it also appeared to him that the islands in front, including those in Seymour's location, were required with the tract on the mainland to make up the area of 6,400 acres called for by the patent.

The Attorney-General's opinion.

The opinion of the Attorney-General, which bears evidence of having been drawn up in haste, is not luminous and the line of argument is not easy to follow, but there is no doubt as to the intent of it. As to the right of the Province to grant the land under water, he had no misgiving, but a grant could give no right to interfere with the navigation of the lake. As to the small islands in front of the location, his opinion was that only such as were shown upon the surveyor's plan should pass by the patent, as the obvious intention was to make the plan the limitation of the grant. "Were all the islands shown upon the plan small islands," he says, "then all shown would I think pass by the grant; but as the Shangoinah cannot properly be included in the words, 'the small islands in front,' the expression must be used in either one of the following two senses: that is, either to pass all the islands shown upon the plan with the exception of Shangoinah, or else to point out in a very loose way the extent outwardly to which the location was to go. I think that when we find a group of small islands beyond which the survey does not seem to have outwardly extended all the islands between which and the shore are small islands, that it may be fairly concluded that the latter is the proper construction and that the expression, 'the small islands in front' was not intended to include islands which are outside the most outwardly shown upon the field notes. If evidence were produced showing that all the islands were, or that only those within a certain line were included in the actual computation of area, this would in my opinion have the effect of controlling the effect of the patent, and such evidence would I think be here admitted. But in the absence of any such evidence I consider what I have stated to be the effect of the patent." Accordingly the Attorney-General saw no objection to the grant being made in the terms of the application of Alfred Seymour, excepting thereout the lands granted the Montreal Mining Company, and upon the understanding that under no circumstances should any claim be made against the Government on account of any failure in the grant arising from any question as to the authority of the Government to make the grant or otherwise. The file date of this opinion is 19th December, 1871, and on the same day a ruling in accordance with it was made by the Commissioner of Crown Lands—Alfred Seymour, by his solicitor, agreeing to accept the patent in the terms of the order.

The Commissioner's ruling in favor of Seymour's application.

A new Government orders stay of the patent.

Next day there was a new Government in office, and on 21st December Mr. Sibley heard for the first time of the attempt to dispossess himself and his associates of their mine and works on Silver Islet, when steps were taken to

Group of miners on Silver Islet.

Miners at work on Silver Islet.

Silver Islet. Group of miners on a tram-car.

Silver Islet. Diamond drill at work.

Silver Islet. Main shaft of the mine.

Silver Islet. Engine house at the mine.

Main shaft and office on Silver Islet.

Engine house and main shaft on Silver Islet.

Silver Islet. The tug "Silver Spray" at the landing.

Stamp mills of Silver Islet mine.

Silver Islet. Stamp mills on the mainland.

Frue vanners in the stamp mill of Silver Islet mine.

stay the issue of the patent, which was made out and ready for signature. It was stayed accordingly, and after a full statement for the Sibley syndicate was presented to the new Commissioner of Crown Lands the case was carefully considered. The Surveyor-in-Chief, Thomas Devine, made an examination of the plans of the several locations granted to the Montreal Mining Company and others with the view of ascertaining whether the patents covered the islands in front of them where situated in the same relation to the mainland as Shangoinah and Silver Islet. "I find that the plans of Jarvis location and Prince's location," he stated in a memorandum prepared in May, 1872, "have islands in front at even greater distances from the shore than Silver Islet and Shangoinah, which are clearly embraced in those locations. If Shangoinah, Silver Islet and the adjoining reef were omitted from the area in Woods location, the quantity of land would fall short of the 6,400 acres, clearly indicating that these islands were included as being part of the location." Furthermore, he found that the location on the original plan was shaded yellow, and that the shading embraced Shangoinah, Silver Islet and the adjoining islands, "thus presenting the clearest evidence that the intention was to convey them." All the papers on file in reference to the lands, together with Alfred Seymour's application, were considered in Council on 22nd June, and the minute shows that the application was not granted. An application for a water lot in front of the location covering 341 acres was put in by Mr. Sibley on 5th April, 1872, which was granted on 12th July; and on 23rd May of next year a further grant of a water lot in front of the location was made covering an area of 4,833 acres, the Government price being $1 per acre. The total area of the location at the end of 1873, including lands purchased for timber, was 15,150 acres.

Report of the Surveyor-in-Chief.

Seymour's application denied.

Area of the location extended by water lots.

DETAILS OF OPERATIONS ON SILVER ISLET.

The materials for a story of Silver Islet mine from first to last must be looked for in the annual reports and other official papers, and unluckily a set of these does not seem to exist anywhere. Messrs. Sibley, Frue, Trowbridge, Ward and almost every other leading man who was connected with the enterprise are dead; the papers at the head office in New York are scattered and lost, and although I have applied in many likely quarters I have not succeeded even in getting together all the annual reports. The best collection is in the hands of W. M. Courtis, M.E., of Detroit, which has been placed at my disposal, and some others, along with special reports and papers, I have received from Henry S. Sibley of Detroit, one of the trustees of the present owners, from Judge Kingsmill of Toronto, and from James W. Cross of Silver Islet.

Materials for the story of Silver Islet.

SUPERINTENDENT FRUE'S NARRATIVE.

One of the best sources of information on the first few years of Silver Islet is to be found in a sketch prepared by Superintendent Frue and published in he report of the board to the shareholders for 1873.

Beginnings at Silver Islet under W. B. Frue's management.

On the day that Mr. Sibley arranged to purchase the locations of the Montreal Mining Company he wired Mr. Frue at Houghton, and that same day (30th August, 1870) Mr. Frue chartered the steamer City of Detroit at Houghton to cross the lake. A hoisting engine and all kinds of mining supplies were got on board, and a working force of 34 men. With a heavy scow and a raft of 20,000 feet of square timber in tow they started for the north shore and arrived at Silver Islet on the morning of 1st September, on which day according to arrangement the purchase was perfected. As soon as the supplies were unloaded the islet and its surroundings were examined, plans were formed, and the construction of cribs was commenced. The islet as described by Frue "was a small barren rock, the greatest width of which was seventy feet and length eighty feet, and in no place rising more than eight feet above the water, its position being about three-quarters of a mile from the mainland and exposed to a sweep of 200 miles of lake Superior."

The Islet, and formidable works for its protection.

By working eighteen hours a day they succeeded in thirty days to put in place 460 feet of cribbing, thoroughly bolted together, filled with rock and having an average depth of thirteen feet. Inside of the cribwork was a coffer-dam built of clay and other materials brought up from Detroit, which enclosed 70 feet in length of the outcrop of the vein, and the water in this space having been lifted out by steam syphons mining was commenced on 5th October. Good progress was made until 26th October, when 200 feet of the breakwater was carried away by a heavy southeast gale, the coffer-dam was damaged, and the pit opened on the vein was filled with rock from the cribs.

A series of disasters.

The breach was repaired with a double line of cribwork, having a base of 26 feet, the coffer-dam was restored and the pit cleaned out; November 18th mining was resumed, and on the 26th the last shipment of ore for the season was made. The value of ore raised and shipped from 5th October to the close of navigation was $108,000. Soon after making the last shipment another loss was suffered in the carrying away of a portion of the breakwater and about 3,000 tons of rock. The works were nearly in ruins, everything upon and around the islet was covered with ice, the supply of timber was almost exhausted, and the future looked dark and foreboding. A reward was offered to any parties who might find a pinery within four miles of the works, and in a few days a grove of Norway pine was discovered on the northwest slope of Thunder Cape mountain which afforded an ample supply of timber. The damages were again repaired, even more substantially than before, and mining was resumed. There was no further interruption until the 8th of March, when sea after sea came rolling in heavily laden with ice, battering down the works as if they were mere reeds, "and it seemed as though the water would surely succeed in regaining the whole of its lost territory and in driving its invaders from the ground." Storm followed storm during this month, sweeping away the cribs as soon as they were placed in position, causing a total loss of 50,000 feet of timber and 6,000 tons of rock, and leaving what it did not carry off a total mass of ruin. "This was a severe lesson," Frue writes, "and coupled with the remark made by my foreman at the time that 'I never could make anything stop there in Christ's world,' fully convinced me of the

strength of the element with which I had to contend." To replace the cribs a new line of breakwater was commenced which faced the southeast, as this was the most exposed point. The structure had a base of 75 feet, strongly framed with five separate bulkheads, and was built on the outer face at an angle of 45°, the highest being 18 feet above the lake; yet in spite of this altitude the sea would occasionally roll over it in volumes. When this work was completed the mine had attained a depth of 50 feet; or rather it was an open cut 45 feet long and sunk to 50 feet. To keep out the water which would flow over the walls during heavy gales, a system of water-tight timbering was commenced, enclosing two air shafts and a working shaft. The space between this timber work and the coffer-dam was filled with stone and hydraulic cement, thus making it a solid mass and greatly increasing its strength and safety. But notwithstanding the many stoppages and interruptions, there was mined during 1871 ore amounting to nearly $1,000,000 in value. This was of course owing to the great richness of the lode, as is evident from the fact that the greatest number of miners employed at any time did not exceed 20. Soon after the close of navigation however the lode was found to contract and pinch up rapidly and the vein became almost barren of silver, and work was continued to the end of winter before the lode began to open out again and to show some fine bunches of silver. In the summer of 1872 ore was produced in paying quantities, and the shipments during that season amounted to nearly $600,000. In the fall of the year the mine again began to look poor, but in the early part of winter heavy bodies of ore were struck and the output during the winter surpassed the most sanguine expectations. In the spring of 1873 the fine show suddenly disappeared, and during the summer and fall the stopes continued to produce only an ordinary quantity of silver. The total shipped during the year was 364 tons, amounting in value to nearly $426,000. On 24th October the shaft had reached a depth of 292 feet, and up to that time nothing more than an ordinary quantity of water had been encountered. But on that day a large feeder of water was struck at the bottom, which at once drove the miners from work at that point, the water rising about ten feet per hour. The mine was supplied with 5-inch and 6-inch draw lifts, and although an 8-inch plunger was in reserve at the surface Mr. Frue deemed it advisable to telegraph an order to Detroit for a 12-inch plunger. This was completed and shipped on 14th November, but the steamer was frozen in at Houghton. And to add to the difficulties of the situation, a heavy storm from the southeast came on about the middle of November and damaged the works to an extent of $2,000, followed on 1st December by another southeaster which wrought a destruction of $9,000. This last tore away 350 feet of submerged cribs and caused a loss of 20,000 feet of timber, 7½ tons of bolts and 5,000 tons of rock. The breach was in the centre of the main breakwater, which had a height of 20 feet, and 60 feet of it was carried away. The blacksmith's shop, which stood inside this breakwater and about 40 feet from its outer face, was completely demolished; in fact rocks were whirled around the islet like hailstones, and a number of the buildings were damaged to a considerable extent. In the meantime a con-

Great richness of the lode.

A flow of water struck in the shaft.

Further damage to the works by storms.

stant fight was kept up to hold the water in check at the 40-fathom level while the 8-inch plunger was being dropped. Frequently it would gain six to 20 feet, owing to frequent breakings of the rods and connecting chains, caused by the extra speed at which the pump was worked; but from the time that the 8-inch plunger was fitted in on 8th January, 1874, the water was easily controlled, the flow into the mine not exceeding 80 gallons pe· minute.

At this time four parties of miners were drifting on the 50-fathom level north and south from the shaft, and the winze from the 40- to the 50-fathom levels at a point 55 feet north of the shaft was down 20 feet, producing ore in paying quantities, but the stopes on the back of the 40-fathom level were not producing much silver fit for packing.

Packing ore and stamp rock.

The entire product of the mine thus far made available had been obtained from what was termed "packing silver," that is silver ore rich enough for packing in bags and barrels to Wyandotte, where it was smelted without any preparatory treatment. The ore thus shipped varied in value from $400 to $7,000 per ton, the general average being not far from $1,500 per ton. In addition to the amount realized from the ore shipped, about 20,000 tons of stamp rock was piled up on the islet, the value of which was roughly tested by the shipment of 400 or 500 tons to Wyandotte, where a portion of it was treated in lots of 10 tons and its value ascertained to be from $40 to $50 per ton. There were besides thousands of tons of similar rock left standing in the mines, awaiting the erection of a stamp mill. "I am perfectly satisfied," Frue reported to the shareholders, "that if the rich packing ore should disappear entirely, the mine as now equipped with the addition of a stamp mill could be worked and a handsome profit returned to the parties interested."

Character of the vein as shown by the works.

In describing the vein as it had been shown up by the works at this stage, Mr. Frue said it was well defined at points, having good walls or cleavages but not uniform in width, opening out at points to 12 or 15 feet and again closing up to a string of not more than six inches. The average width however might be put down as from four to five feet, although aside from the vein proper there were several strings or feeders carrying rich packing ore, some of them at a distance of 30 feet. "The vein substance generally consists" according to Frue, "of calcareous spar and dolomitic spar, with quartz, in which is enclosed occasional masses of diorite wall rock, slate and plumbago. The contained minerals are galena, zinc-blende, iron pyrites, kupfer-nickel, cobalt ore, with small quantities of antimony, native silver, and silver glance or sulphuret of silver. The deposit of silver is found at the intersection of the vein with an immense belt of diorite and plumbago. This diorite is an intrusive mass, cutting nearly perpendicularly through the original more or less horizontal formation of slates and sedimentary or silicious sandstone." The vein on leaving the islet, he said, was easily traced across Burnt island and for some distance on the mainland; but in neither of those places had the rock or vein substance shown above $11 of silver to the ton. By several others also the vein is described as cutting Burnt island and

extending to the mainland across the site of the village, but by some (including Mr. Cross, who has been a quarter of a century on the location) it is believed to lie further west.

BUSINESS OF THE COMPANY IN 1873.

For the calendar year 1873 the receipts from sales of silver reached a total of $547,556, and the balance sheet for the year showed the following assets and liabilities : Assets and liabilities.

Assets.

Real estate and mines	$5,744,613.12
Wyandotte Silver Smelting Works' stock	55,500.00
Mine equipment and machinery	7,066.04
Buildings' account	79,783.98
Construction account, docks, harbor, breakwater, etc.	135,272.10
Tugs account	25,460.73
Burleigh drill and air compressor	4,510.66
New engine and hoisting machinery	31,811.96
Mine agent W. B. Frue, supplies, etc	122,964.44
Insurance scrip, Atlantic Mutual Insurance Co	7,990.00
New York office furniture, etc	1,150.19
Cash in bank	11,735.72
Making a total of	$6,227,858.94

Liabilities.

Capital stock	$6,000,000.00
Bills payable	75,000.00
Drafts of mine agent in transit	10,337.09
Balance	142,521.85
	$6,227,858.94

Some of these items show the enormous expense at which operations were conducted, owing to the isolated position of the works. The operating force had to be brought from a distance at considerable outlay, and would often refuse to go to work when they arrived at the islet, or take advantage of the first opportunity to abscond. But cost of mining was a small item compared with the expense of constructing and maintaining suitable protection in the form of breakwaters and a coffer-dam so as to enable mining to proceed without interruption. The buildings for employés at the islet were not only protected by breakwaters, but were constructed on timber foundations built in the form of large cribs and raised high enough to shield them from the fury of the lake in a measure if the breakwaters should be carried away. Docks for steamboat landing, harbor breakwaters for the protection of tugs and scows, and buildings on the main shore to afford accommodation for the employés also added largely to the cost of the enterprise. In the matter of supplies, it was necessary to carry over nearly double the amount required, which were stored away at separate points as security against total loss by fire. If one or two magazines were destroyed by fire or blown up, there was sufficient powder in the third to carry the mine through the winter. Staple articles of provisions, such as flour, beef, pork, etc., were distributed

Heavy costs of the enterprise due to isolation of the works.

early in the fall among the various dwelling houses in quantity to supply the occupants during the greater part of the winter, and surplus supplies were stored at three different points. These were sold at a low margin of profit so as to enable boarding-house keepers to maintain the standard rate of board, which was $14 per month, and to keep intact the established rate of wages, which was $40 per month, or $26 clear of board. Every precaution was taken at the islet, too, to protect the lives of miners in case of fire, such as the sanding and covering of buildings with mineral paint, keeping in constant readiness two steam fire pumps, and maintaining vigilant watch day and night. Several old buildings were demolished and new ones erected at a greater distance apart, thus diminishing the risk by fire, and a large reading-room and library building provided a resort for the men when off duty.[16] On the mainland there were two churches, and a school maintained free of charge for the instruction of the young.

A tribute to Superintendent Frue.

To have accomplished so much within a little more than three years in the face of so many opposing odds was deserving of a tribute of praise, and in closing their report for 1873 the board refer to the remarkable energy, perseverance, inventive genius and fidelity of their superintendent at the mines. "Struggling against difficulties and dangers which would have appalled other men, he has never lost his heart or his head; ready to plan, prompt to execute, he has met and conquered every obstacle as it presented itself; and in the opinion of the board of trustees is mainly to be credited with the present satisfactory condition of our valuable property."

[16] From Mr. Cross I learned that the four boarding houses on the islet were occupied respectively by (1) Norwegians, (2) Cornishmen, (3) men of all other nationalities, and (4) by officers of the mine. The other buildings on the islet consisted of a blacksmith's shop, shaft house, rock house, engine and boiler house, a saloon and reading room with hospital in the second flat, and a search house, where every man had to enter upon coming up out of the mine and pull off his boots to be searched for silver. At first no liquor was allowed on the location except for medicinal purposes, for which a supply was kept in the company's store. But in the course of time the whiskey pedlars began to ply their trade, camping two or three miles out from the village and selling the vilest stuff to the men. Then Mr. Frue proposed that the store should take out a license, and permission was given each employé to buy a quart every Saturday night as long as he behaved himself. Whenever a man got drunk and received a bad mark, his supply was cut off. The misrule of the camp led to the building of a gaol on the mainland, back of the village. It was a structure of squared logs, 22 by 30 feet, with five cells, a day room, and an office and bed room for the gaoler. Previous to this rows were of frequent occurrence, and disorderly persons had to be taken to Port Arthur for trial before the police magistrate there, Mr. D. D. Van Norman. The gaol proved itself to be a reforming institution, and was as good as fifteen policemen. The married men had homes on the mainland, and tugs made five or six trips daily to convey them to and from the islet. The single men boarded on the islet, and not having the same opportunity as the others to get supplies of liquor, representations on the subject were made to the Superintendent. Mr. Frue devised a plan to meet the case. A room in one of the boarding houses was fitted up with a unique bar, which remains to this day pretty much as it was twenty years ago. It stands about five feet high, and the only way to get behind it is to climb over it. The empty shelves are still intact, and over them is suspended a blackboard marked off by white lines into squares of 4 inches, numbered up to 300 or more. Each miner or other employé on the islet was given a round ticket of cardboard with his number upon it, and whenever he called for a drink it was chalked down against him in the square of the corresponding number upon the board. The allowance was three drinks per day, but if a man was civil he might have an extra drink. Fightings were frequent on the islet, especially on Sunday, and often on such occasions the Riot Act was read by Mr. Frue, who was very firm in enforcing order. "I give you five minutes to get off the islet to shore," he would say, "and you shall go if it takes every man on the mainland to carry you off." The machinery on the islet consisted of two engines, made at Hartford, Conn., of 100 h. p. each, which ran alternate weeks, three air compressors, a grooved friction hoist driven by the fly-wheel of the engine, and two pumps of 14-inch pipes driven by the same engine. The men worked three shifts of eight hours each in the mine, and the surface men ten hours, quitting at 4 p. m. on Saturday. No Sunday work was allowed except in case of a breakdown.

ERECTION AND EQUIPMENT OF A STAMP MILL.

The stock of low grade ore at the mine led the Company, acting upon the advice of Mr. Frue, to take steps for treating it, and during 1873 they caused experiments to be made in Colorado, Nevada, Wyandotte, New York, and at the mine, to ascertain the most effectual and economic mode of treatment. The conclusion reached was based on the results of experiments carried on by Mr. Frue with the use of vanners improved and perfected by him, and which are now known all over the world as the Frue vanners. In a small brown building which stands on the lake shore at the east end of the village, where a stream of dark water comes rushing down the hill-side by the graveyard, he built and ran his trial machine, power having been obtained by throwing a dam across the fall ten yards above the creek's mouth. The work done by the machine was so satisfactory that orders were given to put up a mill and equip it with stamps and Frue vanners. The vanners were an improvement on the endless travelling belt used up to that time for dressing slime in many mills, whereby a secondary agitating or shaking motion in addition to the progressive one was given to the belt. In a paper read at the New Haven meeting of the American Institute of Mining Engineers in February, 1875, Walter McDermott of Silver Islet, now of London, Eng., described its operation as follows : The Frue vanners.

"As first made for experimental purposes, the belt was 12 feet along its upper or dressing surface—about 27 feet in all—and 20 inches in width. A number of machines have since been built in which the belt is four feet wide. The capacity of the smaller size is three tons in 24 hours. Of course, like every dressing machine made, or ever likely to be made, the results obtained are in proportion to the previous sizing of the ore ; but the one point in which this concentrator excels others is in the working of fine slimes. Experiments have been made on slimes flowing from the agitator of the ordinary Western amalgamating apparatus—slimes so fine that after persistent draining they still retain 33 per cent. of water—and by the proper regulation of the machine a regular and slow discharge of impalpable galena and zinc-blende was delivered over the head of the belt. The valuable effects of the shaking motion are perceived at once by disconnecting the crank-shaft, when the capacity of the machine is at once reduced ; the sand packs and the water cuts channels through it, and the tailings become perceptibly richer. Experiments have been carried on for the last two years on a variety of ores of lead, copper and silver, and during that time many improvements have been made in the details of concentration, so that the machine as now manufactured is simple, durable, self-acting, and requires very little power to run it. . . . Twenty washers with belts of four feet in width are now on the ground, with batteries, stamps, shafting and all machinery for a mill capable of treating from 100 to 150 tons a day ; and it is expected that by the spring of 1875 one-half of the mill will be running." [17]

Work upon the mill (a large frame structure of five floors) was commenced in 1874, and as finally equipped its plant consisted of four steam boilers, a 250 h. p. engine, three friction hoists for raising ore into the mill, The mill in operation.

[17] Trans. Am. Inst. Mining Engineers, vol III, 1874-5, pp. 359-60.

two Blake crushers, ten Fraser and Chalmers batteries of five stamps each, and 22 Frue vanners, and the total cost was $93,742. The stamp rock did not turn out to be nearly so rich as the trial tests conducted at Wyandotte had led the officers of the Company to expect, but from the time it was started in the spring of 1875 to the beginning of October, 1876, the mill produced concentrates to the value of $225,180, according to a statement in a special report made by Mr. Learned to the board of directors.[18]

FINANCIAL DIFFICULTIES.

A record of six years' production.

The mine was now getting into financial difficulties, as for two or three years the production had been falling off. The following table, compiled from Mr. Macfarlane's paper, shows the yield in ounces of fine silver for each of the years 1870-75 :

Year.	Ounces.
1870	70,887.10
1871	494,563.10
1872	310,744.02
1873	289,763.77
1874	250,021.75
1875	145,902.50

Being a total in the six years of 1,561,882.24 oz. of fine silver.[19] The largest yield was in 1871, and was obtained at no great distance from the surface, Unfavorable changes in the vein material were met with in the fall of 1873. and had continued in the lower workings of the mine throughout the ensuing three years. The result was a deficit on 1st October, 1876, of $335,615, and a mortgage on the real and personal property of the Company. A special committee, composed of Edward Learned, ex-treasurer, John J. Marvin, treasurer, and Carl O. Wederkinch, mining engineer, was appointed to examine the mine and works, as well as expenditures, values of personal property and general accounts. The general aspect of the mine was reported under date of 5th October, 1876, to be as follows :

Special report on the mine and works.

Collar of shaft, 10 feet above surface of the lake.
Main shaft, 8 by 14 f., 555 f. below lake.
First level 90 f. below lake, driven south from centre of shaft 123 f., north 72 f.
Second level 130 f. below lake, s. 132 f., n. 33 f.
Third level, 165 f. below lake, s. 132 f., n. 72 f.
Fourth level, 225 f. below lake, s. 138 f., n. 78 f.
Fifth level, 285 f. below lake, s. 147 f., n. 110 f.
Sixth level, 335 f. below lake, s. 384 f., n. 144 f.
Seventh level, 407 f. below lake, s. 234 f., n. 72 f.
Eighth level, 479 f. below lake, s. 273 f., n. 69 f.
Ninth level, 550 f. below lake, s. 276 f.
Tenth level, reached from winze 148 f. south, 624 f. below lake.
Four winzes about 70 f. north of shaft, from third to eighth levels.

[18]A table in Mr. Macfarlane's paper (Am. Inst. M. E., 1879), gives the monthly operations of the mill from May, 1875, to November, 1876, inclusive, from which it appears that the total quantity of ore stamped was 24,446 tons, and of concentrates produced $541\frac{1}{2}\frac{0}{0}\frac{8}{0}$ tons. The silver in the concentrates is given as 226,873 oz., and the total cost of dressing was $48,145.

[19]The total currency value of the silver produced was given as follows to date of 5th October, 1876, in the special report of the first treasurer, Mr. Edward Learned :

Prior to formation of Silver Islet Co., Feb. 1872	$807,802 18
Realized by Silver Islet Co	1,374,234 76
Estimated at furnace and en route	55,442 90
Total	$2,237,429 84

Between the first and third levels the whole vein was stoped out, and south of the shaft it was stoped to the fifth level, and down to the seventh level it was only partly stoped in both directions. Between the sixth and seventh levels a corner near the shaft produced $113,000 of silver from 65 tons of ore, but below the seventh level no stoping was done. Occasional cross cuts had been driven at right angles to reach what was known as the east vein, from which a large quantity of rich ore had been stoped out, although at the surface this branch of the vein appeared to be barren. Extensive explorations had also been carried on with a diamond drill, chiefly downward from the eighth level, the bore holes varying in length from 55 to 293 feet and aggregating 3,726 feet, the cores of which were found to be favorable in every respect except the non-appearance of silver.

From his study of the shaft and workings of the mine, Wederkinch was able to make some interesting observations. The vein itself was found to dip towards the east at an average of 21 inches for every six feet down, and while the average width was five feet it changed in places from one to 20 feet or more. "These changes," he stated, "are easily accounted for when we observe that a diorite belt 200 feet wide, crossing Silver Islet, shows a displacement of about 80 feet, so that the diorite each side of the vein only overlaps 120 feet, proving the east side to have moved north or the west side south, or both to have moved in opposite directions; thereby, wherever the break originally has not been straight, hollow places may have met opposite, making the vein very wide, and where rounded surfaces came together near enough to touch there would be little or no vein for some distance." Samples taken from the vein at various points, including the supposed extension across Burnt island and on the mainland, satisfied Mr. Wederkinch that wherever galena belts existed, as towards the north, there was little silver, although they might be underlaid with chimneys or deposits of richer ore, and that where there was little or no galena, as towards the south, the vein was richest in silver. Considering the results of the samplings, he came to the conclusion that the shaft was started at about the junction of the lead belt north and the silver belt south, but that the silver bearing part of the vein dipped considerably to the south, as the first ore body would seem to indicate, that the lower levels and lower part of the shaft were all north of the silver-bearing belt, and that the smaller bodies of silver ore met with in these workings were what might be called drippings from the larger mass found above, which seemed to have been thrown up from the south; but no dip or angle separating the two belts could be given, as in the filling of the vein there was nothing to guide them.

Observations on the vein and dike.

OPERATIONS UNDER A NEW COMPANY.

The report of this committee led to action being taken by the shareholders, under which three trustees negotiated a purchase of all the lands and property of the Silver Islet Company and of the lands of the Ontario Mineral Lands Company on the north shore of lake Superior, and proceeded to organize a new company under the laws of the State of New York, styled The Silver Islet Consolidated Mining and Lands Company. The capital of this

The Silver Islet Consolidated Mining and Lands Company.

stock company was fixed at $1,000,000, divided into 40,000 shares of $25 each, and to it all the property was transferred "for its capital stock 'full paid' and $400,000 first mortgage bonds." The formal organization of the new company was effected 3rd April, 1877, and for some time before and after that date operations at the mine were very restricted.

Rich roof of the mine.

It was known that in the roof of the mine there was a large body of rich ore, estimated to be worth from $350,000 to $500,000, and a scheme for winning it by the construction of an artificial roof was decided upon, but as explorations carried on in other parts of the mine led to rich strikes being made, the work on the roof was suspended. In the summer of 1877 the pumps were disconnected below the third level, to reduce as for as possible the running expenses at the mine, and in August work was resumed at the south end of the first level to reach a deposit of ore 80 feet beyond it, as revealed by a boring of the diamond drill. In this and other ways packing ore to the amount of 23,850 ounces was taken out up to the end of the year. The second and third levels were explored in the same way, with results so encouraging that the mine was unwatered again and work was carried down from the fourth to the tenth levels. "Silver of unparalleled riches was found in the winzes, in the drifts and in the stopes, and rich stamp mill rock abounded in all workings, the vein north of the shaft being peculiarly productive," the directors say in their report to the shareholders at the meeting of 4th February, 1879, and the year 1878 closed with a production of silver estimated at 721,632 oz., of which 551,111 oz. was furnished from packing ore and 170,521 oz. from the stamp mill concentrates. "It is worthy of mark and gratulation," the report of President Learned said, "that this Company has so rapidly emerged from its depressed condition, that its indebtedness is in process of immediate and full discharge, and that its mine, complete in all its equipments and appurtenances, shows evidences everywhere of future value, measurable only by skill and labor."

Great winnings of silver in 1878.

Plans for lateral extensions made

The next yearly report however showed that too high an estimate had been placed on the value of the ore in stock at the end of 1878, the difference between the estimate and the amount realized being $127,022. The workings were carried on steadily during the year, and the winze following the dip of the diorite started at the ninth level was sunk to a depth of 283 feet below that level, being 843 feet from the surface. On the vein crossing Burnt island too a shaft was sunk to a depth of 162 feet, the purpose being to put it down to the depth of the ninth level on Silver Islet and connect with it.

and abandoned in favor of deep sinking.

In 1880 the directors decided, in view of the financial condition of the Company, to confine expenditures exclusively to Silver Islet, where the indications of immediate valuable discoveries were more promising and certain than elsewhere. The superintendent and others familiar with the mine had long entertained the opinion that the workings should be extended downwards as rapidly as possible on the incline of the diorite dike, in which the rich mineral had been found in the earlier workings. In the absence of knowledge to the contrary, this dike was assumed at first to be vertical, and the main shaft was sunk vertically to the ninth or 560-foot level, near which it passed

into the adjacent slates; and so it became necessary by a change of location and direction to provide for the extension of the shaft on the line of the dike.[20] This work had been commenced five or six years before, and in April of this year it was completed to a depth of 414 feet below the ninth level. Drifts started at the bottom of it showed the vein to be highly promising, especially towards the south, where at 90 feet very rich silver was found in quantities and relations to the composition of the lode which indicated an extensive and valuable deposit. Being at the contact of the diorite dike with the slates, in position similar in all respects to that of the rich bonanza found in 1878—and, like it, with native silver at the top and huntilite and macfarlanite immediately below—the theory of the superintendent seemed to be established that the course of the chimney was on the inclined line of junction of the two rocks. Drifting was also carried on upon the upper levels towards the south, with good showings, but the main hope was in the lower levels. Serious difficulty in pushing operations in that quarter however was experienced in hoisting ore and rock, as well as lifting water, by the break of continuation at the ninth level, and it was decided to extend the incline shaft upwards to the surface as rapidly as possible. The work on this section was begun during the year, and as operations could be carried on from several points of attack, it was pushed forward rapidly. But the production of silver had fallen off again, the sales of the year being only 36,374.76 oz., while the stamp rock on hand was valued at $56,000. This source of revenue was supplemented by sales of the Company's stock to the amount of $18,219, by contributions or assessments, $62,913, and by notes discounted, $18,000.

A new working shaft completed.

CLOSING YEARS OF THE MINE.

There is a break in the story of the mine for 1881, but the report of the directors to the shareholders for 1882 does not indicate that the expected bonanza had taken substantial form. "It is useless to disguise the disappointment of the directors," they said, "that thus far, whilst cutting through the 'barren zone' of the vein, although fugitive bunches of rich mineral have been found in the various levels sufficient to awaken daily expectation of more, the long-looked-for bonanza has not been reached" But the discouragement of hope deferred had not permitted any relaxation of effort, and the advance by some of the directors of large sums from their personal resources assured them of confidence in ultimate success. The time had arrived however, it was declared, when the shareholders should ratably assume their proportions of the burdens and bear their part in whatever plan might be devised to pay off the existing indebtedness and provide for more efficiently carrying on operations. The proceeds of silver sales realized only $14,143.74, and the rest of the year's revenue, amounting to $156,500, was made up chiefly of contributions, call loans and notes discounted. The report of the superintendent, Mr. Richard Trethewey, showed that the incline shaft

The directors disappointed, but not disheartened.

[20] There is a discrepancy in the reports as to the exact location of the new shaft as related to the old one. In Mr. Learned's special report of 1876, where it is referred to as a winze sunk from the ninth level, its distance south of the vertical shaft is given as 148 feet; in the board's report for 1879 it was given as 168 feet, and in the report of 1880 as 185 feet.

—which was now the main shaft—was being carried down below the 1,060-foot level, and that the tenth, eleventh and twelfth levels had been driven northward through the dike into the slates ; but in neither the shafts nor the drifts had silver been produced in paying quantities, although it was proven that the vein maintained its general encouraging features as well as uniformity of size and strength.

Encouraging features of the mine,

The year 1883 closed with a deficit of $45,682. The reccipts were mostly derived from bonds, assessments and call loans, and the straits to which the Company was reduced is shown by the sale of such articles as a tug boat, old crushers, ore-bags and laboratory fixtures. The sale of fine silver fell to 1,874.15 oz., which netted $2,010.41, and the value of ore on hand was estimated at $7,500.

but an empty treasury.

The list of directors for 1884 comprised the following—two of whom had been on the board of trustees when the Company was organized in 1870, Messrs. Learned and Trowbridge, and only one other besides these, Mr. Coe, was an original shareholder :

The board's report for 1883.

Edward Learned	Pittsfield, Mass.
William A. Booth	New York.
William A. Langley	New York.
George S. Coe	New York.
C. A. Trowbridge	New York.
B. E. Strong	New York.
John J. Marvin	New York.
George C. Moon	New York.
Myron P. Bush	Buffalo, N. Y.
John S. Newberry	Detroit, Mich.
T. C. Weeks	Boston, Mass.

Their report refers to a proposal to secure financial relief by the sale of Mamainse location on the east shore of lake Superior to English parties, with whom negotiations were proceeding. Further explorations downward at Silver Islet, they said, had been discontinued and operations were being confined to the upper part of the mine.

The superintendent's final report.

The report of the superintendent, Mr. Trethewey, showed that the main shaft had been sunk to the fifteenth or 1160-foot level, drifting upon that level north and south and sinking two winzes upon it, and back-stoping at encouraging points in some of the upper levels. The explosion of a boiler in January caused the stoppage of pumps and machinery for twenty days, during which the water rose in the shaft 330 feet, and the shaft was not pumped out until 15th March. Drifting was immediately commenced on the lowest level, and was carried south 227 feet and north 81 feet. "The vein though well defined," Mr. Trethewey stated in his report, "and carrying quantities of minerals, has not produced the expected amount of silver. A deposit of silver was opened into during the summer, near the end of the north drift, but proved to be small in extent. At this point and in this run of ground a winze is being sunk toward the 1260-foot level, hoping that in its course other bunches may be found. A winze has also been commenced toward the 1260-foot level near the end of the south drift, in the same run of ground in which silver has been found above. In the levels where back-stoping has been

carried on, the vein, although of a very encouraging nature, yielding minerals which are always found accompanying silver, has not produced silver in paying quantity ; still it will be remembered that heretofore we have worked for long periods in ground such as described, and finally been rewarded by encountering rich deposits, and there is no reason why we should not expect similar results again. Ere long," he went on to say, "we shall find ourselves placed in a serious dilemma owing to the non-arrival of our winter supply of coal last fall—a vessel with a cargo of nearly 1,000 tons having failed to reach here, being laid up while en route. The present supply of coal is sufficient to run with until about March 1st, after which we shall find it extremely difficult to carry on the work."

A serious dilemma threatened,

This was written under date of January 20, 1884, and what was feared came to pass a little earlier than was expected. The cause is best told in the words of trustees John J. Marvin and Henry S. Sibley in an official letter printed under date of July 10, 1890:

and the works closed down.

"When work ceased at Silver Islet in February, 1884 (owing to the non-arrival of coal, unfortunately shipped in charge of an intemperate captain in the fall of 1883), the appearance of the vein in that mine was in every respect encouraging."

The incline shaft had reached a depth of 1,160 feet, or to the fifteenth level, and the winze from that level north of the shaft was sunk to a further depth of 90 feet, being a total depth of 1,250 feet upon the vein.

Depth of the incline shaft.

All the property of the Company has since been sold under foreclosure of mortgage and has been vested in the two trustees above named with a view of prospecting it as to mineral, timber, quarry, farming, water power, harbor, fisheries and other values, in order to facilitate its sale in locations or in lots.

The property sold under foreclosure of mortgage.

THE MORAL OF THE STORY.

If there is a moral or a practical lesson in the Story of Silver Islet, it should have value for all time. I will just recall a few facts, the knowledge of which may be useful to men who are prompted to put money into mining enterprises. The properties purchased from the Montreal Mining Company by the Sibley syndicate consisted of eighteen locations, embracing over 100,000 acres of mineral lands. The selling price to the syndicate was $225,000, and in less than three years one of the eighteen locations was sold for $150,000, and little Silver Islet produced enough silver to pay off the whole purchase price, two dividends aggregating $262,666, and nearly $500,000 besides for development and improvement of the property. Then a company within a company was organized, capitalized at $6,000,000, and in the first two years of its existence the shareholders were paid two dividends of $180,000 each, or a total of $360,000, and every dollar of the stock was fictitious. How much more was paid in dividends, if any, I do not know, for some of the annual reports cannot be found. Then the company with $6,000,000 stock was wiped out and one of $1,000,000 formed in its stead, but into which not a dollar of money was put as far as I can make

Salient facts of the Story.

out; only it shouldered a mortgage of $400,000, left as a legacy by the old company, which covered Silver Islet and 100,000 acres of mineral lands besides. Then came one year of plenty which yielded about three-quarters of a million dollars, followed by seven years of famine, and finally the sale of the mine and all the lands under foreclosure of a mortgage. The mine had yielded in all from first to last $3,500,000, and this was the end of it. Thomas Macfarlane in 1879 had uttered a note of warning against the practice of picking the eyes out of a mine. "The product of a mine, like that of a farm," he said, "cannot be forced beyond certain proper limits without bad consequences. Let reserves accumulate in our mines as the 'rests' formerly did in our financial institutions, and mining will become as profitable as banking, if not more so."[21] In European countries mines are worked on a plan to secure continuity of operations and permanency of the mining industry. In the new world, as has well been observed by the first Director of the United States Geological Survey, Mr. Clarence King, the effort often is to get out the largest amount of bullion in the shortest time possible. "The number of precious-metal mines in this country," he wrote in 1885, "which have continued to be productive during a period of ten years is very limited, and the life of many of the most famous and successful ones have been far shorter. Indeed, a bonanza which has required two or three years to exhaust is a rarity."[22] The practical lesson may be found, I think, in these facts; and if you are putting money into silver mines, or gold mines, or mines of any sort, pray don't try to become millionaires in a year, or two, or three. Leave something in the earth for the generations coming after us, for the earth and its people must live on.

Notes of warning.

A. B.

[21] Trans. Am. Inst. M. E. vol. viii., page 253. [22] U. S. Census, 1880, vol. XIII., p. viii.

NOTE.—The foregoing paper was read before the Canadian Club, Hamilton, early in the present year.

SECTION IV.

ANTHRAXOLITE OR ANTHRACITIC CARBON.

By Dr. Arthur P. Coleman.

Coal has so often been reported from one point or another in Ontario, and the report has so uniformly proved baseless, that the public have grown incredulous in the matter; but at length a material closely like anthracite coal has been found in quantities that seem likely to have some economic importance.

On June 16, 1896, Mr. C. H. Collings, of Chelmsford, in the district of Algoma East, reported to the Bureau of Mines the finding of a seam of "smokeless" coal ten feet in width in the township of Balfour. Specimens sent to Mr. Blue were examined roughly by the writer and described as probably an earthy graphitic anthracite. Careful analyses of the purest specimens in Dr. Ellis' laboratory, School of Science, Toronto, show that when free from the intermixed quartz the material closely resembles the graphitic anthracite of Rhode Island.

Discovery in Balfour township.

Owing to pressure of field work I was unable to visit the property until November 1, 1896, when in accordance with instructions from Mr. Blue, Director of the Bureau of Mines, I made as careful an examination as the undeveloped nature of the property would permit. My report, with an introduction from Mr. Blue, was published promptly as Bulletin No. II. of the Bureau of Mines; and the present report contains little further information except as to the results of the boring done on the property.

The deposit occurs on lot 10, concession 1, about seventeen miles west of Sudbury, five miles southwest of Chelmsford, and a mile and a quarter south of the nearest point on the Canadian Pacific Railway. It was in November the property of Messrs. J. R. Gordon of Sudbury and J. M. Clark of Toronto; and I have to thank the former gentleman for serving as guide to the property and for providing a conveyance from Sudbury to the spot and back.

Occurrence of the deposit.

The coaly material occurs as an irregular vein in black fissile slate, mapped by Dr. Bell as Cambrian. The vein runs about north and south up a somewhat steep rocky hill, turns a little to the east on the hill top and pinches out. Towards the south the lower end of the vein is buried under the boulder clay which covers the valley. The length of the vein exposed is about seventy feet, but further excavation may show that it continues south beneath the boulder clay. In width the coaly matter measures at its widest part twelve feet, but, allowing for the dip, its real thickness is probably six to nine feet as estimated by Mr. Gordon.

The coaly material does not form a bed as in a true coal seam, but cuts across the slate, which has a strike of about 60° east of north. The slate walls show a dip running from nearly vertical to 55° towards the east; and they are somewhat irregular and broken, fragments several feet long lying at one point as "horses" in the coaly material.

Mr. G. R. Mickle, of the School of Science, has determined the hardness of the mineral to be between 3 and 4, the hardness of anthracite being given as 2—2.5. The pure mineral is lustrous black, resembles anthracite or albertite in appearance, and forms small plates or irregular cubic blocks, the largest observed being three-quarters of an inch square. Between the plates or cubes there is generally more or less quartz, and in some weathered portions on the surface the quartz remains as a porous, cellular mass. The quartz varies much in amount, specimens from the bottom of the small pit containing less than those from the surface. The only other important mineral present is iron pyrites, which is scattered through parts of the vein, accounting for the sulphur found in some analyses of the material.

Appearance o the mineral.

Complete analyses have been made in Dr. Ellis' laboratory, and his report follows this; so that no further description will be necessary here. It is probably wiser to use the name anthraxolite, applied years ago by Professor Chapman to similar substances from eastern Ontario and other parts of Canada, than to name the substance anthracite, since the latter is found in beds associated with rocks containing carboniferous or later fossils, and is held by geologists to have been deposited as vegetable matter where it is now found; but the mineral here discussed occupies a vein cutting very ancient slates, and must have reached its present position long after these rocks were formed. It should be understood, of course, that the coals and related substances show wide variations. They are not sharply defined chemical compounds like most minerals; and this fact makes it unwise to be dogmatic or over-precise in naming them.

Distinction according to name.

During the winter the government diamond drill has been used in exploring the deposit and Mr. W. W. Roche, the manager in charge of it, has made to Mr. Blue the following report of the work under date of March 22:

Report of exploration by diamond drill.

"I beg respectfully to report the following work done with the Government diamond drill in the township of Balfour, on what is called the Gordon coal mine. The drill was placed 100 feet from and south of the outcroppings of anthraxolite, which appears in a ledge of slate, for the purpose of cross-cutting the formation and determining the extent in depth and width of the mineral. After placing in 27 feet of stand pipe and 32 feet of casing pipe everything was ready to commence boring, and having a good flow of water out of the bore hole the cuttings and every particle of rock or material drilled through was washed to the surface into a trough, securing the same for a close examination. It was necessary to have things arranged in this manner as the shale and slate cuttings were so black that it was impossible to tell when drilling in soft shale or slate whether it was mineral or rock, some of the soft slate or shale cores grinding up so easily that is was not noticeable when drilling. When we reached a depth of 229 feet and drilled five feet further after pulling the rods we only had one foot of slate, and upon examining the cores the anthraxolite in streaks could be seen in some of them; thus showing that we had passed through four feet of the mineral. We continued drilling in slate rock and finished the hole at a depth of 260 feet . . . . While drilling we used principally anthraxolite for fuel in the furnace, and i gave very good results. After getting up a good fire it gave a brilliant blue

flame and also great heat, but the waste was considerable. It took close attention by the fireman to keep the ashes away, and I should judge that fully one-half was waste."

Mr. Roche's report shows that the vein reaches to a considerable depth, since anthraxolite was struck between 229 and 234 feet, having apparently a thickness of four feet. The angle at which the bore hole was driven is not mentioned, but from the diagram accompanying the report the vertical depth at which the vein was found must be over a hundred feet. Permanency of the vein in depth.

The amount of fuel available in this interesting deposit probably reaches some thousands of tons, and may greatly exceed this quantity. It is probable that the vein will prove variable in width, and its real extent can be settled only by numerous drill holes or by actual mining. The vein of albertite in New Brunswick furnishes probably the best analogy to this remarkable deposit, although it was apparently larger, having been traced for 2,800 feet on the surface, with a width as disclosed by mining operations varying from a few inches to fifteen feet. The whole amount of albertite mined is estimated at 200,000 tons. Probable extent of the mineral.

However large this vein of anthraxolite may be, it is unlikely that it will supply quantities of fuel comparable to those of coal regions, where the beds often extend for many square miles. Of course other similar deposits may be found, and very favorable reports have appeared in the newspapers as to finds made in Fairbank township; so that the whole quantity available may be of considerable importance economically, particularly at Sudbury where hard coal is sold for $9 per ton. Unless the percentage of ash proves less when the vein is sunk upon, the quantity of quartz mixed with the mineral will prove a serious drawback, particularly for metallurgical purposes. Possibilities of a large supply.

The source of this fuel is probably to be looked for in bituminous matter contained in the adjoining beds of slate, which carry 6.8 per cent. of carbon. By metamorphic action most of the volatile matter has been removed from the once fluid or plastic bitumen, leaving the solid carbon cracked into small cubes and plates, the spaces being afterwards filled with a network of quartz by the action of circulating waters. As to the age of the deposit, there is no evidence to show that the slates are later than Cambrian, as suggested by Dr. Bell; but it is evident that these slates must have been consolidated and fissured, probably also faulted, before the original bitumen flowed into its present position. In what geological age this took place it would be rash to venture an opinion. Source and age of the mineral.

[1] Geol. Sur. Can., 1876-7, p. 368 and 1888-9, p. 16 T.

CHEMICAL COMPOSITION OF THE ANTHRAXOLITE.

By W. Hodgson Ellis,

Professor of Applied Chemistry, School of Practical Science.

In a paper read before the Canadian Institute[2] Mr. William Lawson and the writer have recorded the results of the analysis made in the chemical laboratory of the School of Practical Science, Toronto, of the coaly mineral from the neighborhood of Sudbury described by Professor Coleman as "Anthracitic carbon or anthraxolite."

Associated mineral matter in anthraxolite.

The quantity of associated mineral matter, chiefly quartz with a little iron pyrites, was found to vary widely in different samples. One specimen gave 36.5 per cent. ash, another 30 per cent., a third 20 per cent, and a fourth, carefully selected, 4.1 per cent. The following is the proximate analysis of an average and of a selected sample:

	Average.	Selected.
Moisture	4.00	4.00
Volatile matter	1.30	1.80
Fixed carbon	74.20	90.10
Ash	20.50	4.10
	100.00	100.00

Prof. Chapman's analysis of a lake Superior sample.

Professor E. J. Chapman, to whom the name anthraxolite is due, applies it to an anthracitic mineral "occurring in veins . . . or filling small cracks" in Silurian and older rocks. He gives[3] a proximate analysis of a specimen of anthraxolite from the lower copper-bearing rocks of lake Superior as follows:

Moisture	2.08
Volatile matter	3.56
Fixed carbon	94.36
Ash	0.00
	100.00

In Minerals and Geology of Central Canada, p. 143, he gives the volatile matter, "including a small amount of moisture," as ranging from 3 to 25 per cent.

Hoffman's analysis of a Labrador sample.

Mr. Hoffmann has given[4] an analysis of a specimen of "anthraxolite from a quartz vein traversing limestones and bituminous shales of the Cambrian system, at Lake Petit-sikapau, Hamilton river, Ungava district, Labrador peninsula, collected by Mr. A. P. Low."

Water	3.56
Volatile matter	2.48
Fixed carbon	86.83
Ash	7.13
	100.00

"The ash which was of a light reddish brown colour, was found by Mr. Wait to consist for the most part of silica. It would appear to be almost

[2] February 27, 1897.

[3] Canadian Journal, vol. x, p. 410.

[4] Report of the Geological Survey of Canada, 1894, p. 66 R.

olely derived from accidental impurities, a view strengthened by the fact hat other fragments of this mineral . . . left on ignition but 0.31 per ent. of ash."

Comparative analyses of anthracite and anthraxolite.

In the following table I have calculated the proportions of fixed carbon nd volatile organic matter to the dry ash-free substance for these three specinens of anthraxolite and I have added, for the sake of comparison, the proxinate analysis of two samples of anthracite similarly calculated, one from an nalysis of Pennsylvania anthracite made in my laboratory, and the other rom an analysis of "graphitic anthracite" from Rhode Island by Dr. Jackson.

	Volatile matter.	Fixed carbon.
Anthracite, Pennsylvania	7.83	92.17
Anthracite, Rhode Island	2.39	97 61
Anthraxolite, Lake Superior	3.64	96.36
Anthraxolite, Ungava	2.78	97.22
Anthraxolite, Sudbury	1.98	97.02

The proximate analysis of the anthraxolites, particularly the last two, losely resembles that of the Rhode Island anthracite, and differs considerbly from that of the Pennsylvania anthracite, which contains much more olatile matter.

Comparison of Sudbury and Kingston anthraxolites.

An ultimate analysis of a carefully picked specimen of the Sudbury nineral, freed as much as possible from associated quartz, etc., gave the ollowing results :

Carbon	94.92
Hydrogen	0.52
Nitrogen	1.04
Sulphur	0.31
Ash	1.52
Oxygen	1.69
	100.00

The specimen contained 2.48 per cent. of hygroscopic moisture. Its pecific gravity was 1.865.

For the sake of comparison we made an ultimate analysis of a sample of nthraxolite from the neighbourhood of Kingston, given us by Mr. Miller, of he Kingston School of Mining, and described by him as occurring in a vein f barite "which cuts the limestone of the Black River formation of the ilurian system. The anthraxolite has been deposited after the barite and ther minerals," (calcite and fluorite) "as it coats them and fills crevices in hem. It is probable it has been derived from the bituminous matter in the imestone.[5] The analysis was as follows :

Carbon	90.25
Hydrogen	4.16
Nitrogen	0.52
Sulphur	0.66
Ash	0.72
Oxygen	3.69
	100.00

It contained 0.96 per cent of moisture, and its specific gravity was 1.365.

[5] G. R. Mickle, Trans. Can. Inst., April 27th, 1897.

Chemical constitution of coals.

Our knowledge of the chemical constitution of the substances which are classed together under the name of coal is almost nil. We know them only from the products of their decomposition. Their inaccessibility to attack by means of solvents and chemical reagents has prevented our acquiring a knowledge of the ingredients which they contain. We can by destructive distillation obtain from them a host of definite chemical compounds, but we have every reason to believe that in most cases these compounds are formed out of the ruins of the original structure and do not constitute parts of it as such. Elementary analysis gives no sharply marked individuals, but a series of infinite gradation proceeding, not by steps, but in an inclined plane.

This idea has been well discussed by Professor Newberry in a very interesting paper,[6] and illustrated by a diagram, which is here reproduced :

Plant—Tissue.

Residual products.	Evolved products.	
Peat.	Carbonic Acid.	
Lignite.	Carbonic Oxide.	
Bituminous Coal.	Carburetted Hydrogen, etc.	
Semi-bituminous Coal.	Water.	
Anthracite.	Petroleum	Maltha.
Graphitic Anthracite.		Asphalt, etc.
Graphite.		Asphaltic Coal.
Ash.		Asphaltic Anthracite.
		Asphaltic Graphite.

Views of the origin of natural gas, petroleum and asphalts.

Professor Newberry holds in common with most geologists that such bodies as natural gas, petroleum and asphalts have been derived in all cases from the decomposition of vegetable or animal matter, in an analogous manner to the production of gas and tar from wood by the action of heat in a closed vessel—the various kinds of coal representing the charcoal left behind.

Some chemists, as Mendelejeff, are inclined to attribute an origin to these hydrocarbons independent of life by union of carbon and hydrogen through such means as the action of water upon metallic carbides, as is seen in the production of acetylene from calcium carbide, now commercial.

Coals and bitumens.

Whichever of these views may be correct, the fact remains that we have two series of carbonaceous bodies—the coals and the bitumens, which although fairly wide apart at the starting point tend to draw together towards the end, and finally become almost indistinguishable from each other.

By the action of heat we can produce changes similar to those which are observed in ascending either of these series, and finally a very similar product is obtained whichever of the series is operated upon. The charcoal or coke obtained at high temperatures are very similar, whether made from wood, coal or petroleum :

	Carbon	Hydrogen	Oxygen
Charcoal from wood	97.96	0.63	1.41
Coke from coal..........................	98.31—	0.28—	1.41
Coke from petroleum	97.86—	0.49—	1.68
Anthraxolite (Sudbury)...............	96.40	0.50—	3.10

[6] Annals N. Y. Acadamy of Science II., p. 9, 1882.

The end of both these series in carbon, and carbon may be either crystalline as in the diamond or graphite, or amorphous.

Forms of carbon.

Schungite, a mineral from Lake Onega, Russia, composed of carbon with 0.4 per cent of hydrogen, and graphitoid from the Erzgebirge in Saxony consisting of carbon with 0.24 per cent. of hygrogen, may almost be looked upon as the amorphous form of native carbon.

Connecting links.

Speaking from a chemical standpoint, it seems that the Sudbury mineral forms the connecting link between such minerals as these and albertite and such anthraxolite as that from Kingston, just as the Rhode Island graphitic anthracite forms the connecting link between graphite and ordinary anthracite. Thus:

Peat.	Petroleum.
Lignite.	Asphalt.
Bituminous Coal.	Albertite.
Anthracite.	Anthraxolite.
Graphitic anthracite.	Graphitic anthraxolite.

Graphite.

Rhode Island anthracite.

The graphitic anthracite of Rhode Island, which resembles in its chemical composition the Sudbury anthraxolite, resembles it also in its physical properties. Its specific gravity is in some samples as high as 1.85. The Sudbury mineral has a specific gravity of 1.865. Ordinary anthracite averages 1.65. The Rhode Island coal is thus described by Professor Ralph S. Tarr.[7]

"This region is of interest not for the amount produced but for the peculiar nature of the coal. Although never a heavy producer this region has been worked more or less continuously for a long period. A few thousand tons were annually produced, but this burns with such difficulty that it is of use only where there is a strong draught, as in a blast furnace ; but this difficulty is partly compensated for by the length of time which it burns and the large amount of heat furnished. A very peculiar industry for a coal region has been recently begun upon the basis of the graphitic nature of these anthracites. This is the manufacture of pipe coverings, stove facings, stove blacking and paints, which show the peculiar condition of the coal beds. The graphitic nature of the anthracite is due to the metamorphism of the coal-bearing beds, by mountain building forces which have resulted in altering the nature of the enclosing rocks in some cases into well defined schists."

As a fuel the Sudbury mineral behaves very much in the way here described.

Heating power of the Sudbury mineral.

A determination of its heating power by Mr. Lawson and the writer, by means of Fischer's Calorimeter gave 7,490 calories as the heat evolved by the combustion of one gramme of a sample containing four per cent. of ash. That is, one gramme of the substance in burning gives off heat enough to raise 7,490 grammes of water, one degree Centigrade ; or one pound will give heat enough to raise 13,482 pounds of water, one degree Fahrenheit ; or 74.9 pounds of water from the freezing to the boiling point ; or to convert 13.9 pounds of water into steam.

[7] Economic Geology of the United States, p. 314.

Comparative heating power of fuels.

The following table gives the heating power of various fuels expressed in calories for one gramme :

Fuels.	Calories for 1 gramme.	Observer.
Petroleum	10,000	Deville.
Wood	4,740	Fischer.
Peat	5,430	Fischer.
Lignite	6,905	Scheurer-Kestner (mean of 6).
Bituminous coal	8,552	Scheurer-Kestner (mean of 3 Welsh coals).
Anthracite	7,484	Mahler.
Anthraxolite, Sudbury	7,490	E. & L.

The determination of the heating power of the Sudbury anthraxolite was attended with some difficulty on account of its small inflammability and the slowness of its combustion. In making the ultimate analysis we were met by the same difficulty. The resemblance to graphite in this respect forced itself on our attention.

Analyses of related carbonaceous minerals.

In the following table I have calculated the analysis of a number of coals, asphalts and allied bodies to the dry, ash-free substance in order to allow them to be compared with each other. In many cases the figures given are the mean of a number of analyses. The data for the compilation of this table have been taken, where not otherwise stated, from Mills and Rowan's volume on Fuel in Groves and Thorp's Chemical Technology, from Fischer's Die Chemische Technologie der Brennstoffe and from Dana's Mineralogy.

	Carbon.	Hydrogen.	Oxygen and Nitrogen.	
Wood and Coal.				
Wood	51.1	6.1	42.8	Chevandier (mean)
Peat	60.1	6.0	33.9	Regnault & Muld (mean of 9)
Lignite	69.1	5.3	25.6	Sheurer-Kestner (mean of 6)
Bituminous coal	84.6	5.4	10.0	Phillips (mean of 97 English coals).
Anthracite Pennsylvania	93.7	2.5	3.8	Regnault, Schulze, Mahler (mean)[8]
Graphitic anthracite (Russia)	96.7	1.3	2.0	Scheurer-Kestner.
Wood charcoal	88.0	0.6	1.4	Violette.
Coke	98.3	0.3	0.3	Mahler.[8]
Petroleum, Asphalt, etc.				
	Carbon.	Hydrogen.	Oxygen and Nitrogen.	
Crude petroleum	83.0	13.9	3.1	Mahler.[8]
Asphalt (Mexico)	83.3	10.8	5 9	H. Endemann (Joun. Soc. Chem. Ind.. xv. 872).
Albertite	86 0	9.0	5.0	Whetherill.
Anthraxolite (Kingston)	90.5	4.2	5.5	E. and L.
Graphitic Anthraxolite (Sudbury)	96.4	0.5	3.1	E. and L.
Coke from petroleum	97.9	0.5	1.6	Mahler.[8]
Graphite and Related Minerals.				
Schungite (lake Onega, Russia)	99.2	0.4	0.4	Inostranzeff.
Graphitoid (Erzgebirge) Saxony)	99.8	0.2	0.0	Sauer.
Graphite	100.0	0.0	0.0	

[8] "Obus Calorimetrique pour l'Estimation de la Valeur des Combustibles," par M Ch. Talansier.

SECTION V.

GEOLOGY OF THE NIPISSING-ALGOMA LINE.

By Edward M. Burwash, B. A.

The following report is a statement of the geological work done during the past summer in connection with the survey of the boundary line between the districts of Nipissing and Algoma. The ground traversed extends from the upper waters of the Vermilion and Wahnapitae rivers to within about 35 miles of lake Abitibi, including 44 miles of the Hudson Bay slope, and lies within the great northward extension of the Huronian belt between lake Wahnapitae and lake Temiscaming. Introductory.

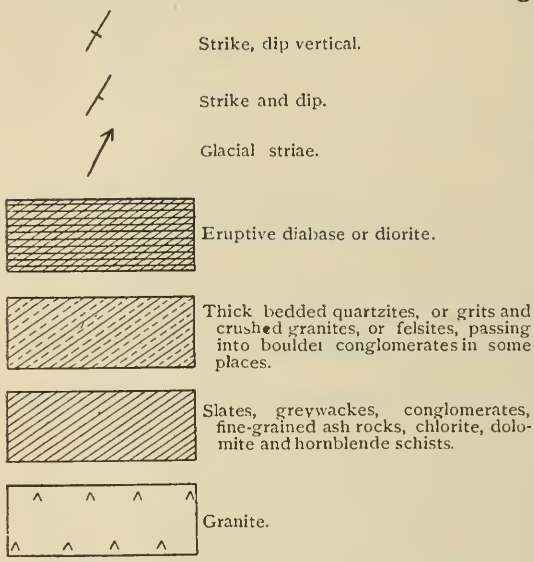
The aim of the work was to examine the country on both sides of the line with a view to ascertaining its resources in timber, soil, and especially in minerals of economic value. Guidance and assistance were afforded by written instructions drawn up by Mr. Aubrey White, Assistant Commissioner of Crown Lands, and Dr. A. P. Coleman, Geologist and Mineralogist of the Bureau of Mines, of which the following are copies: Instructions for the work.

"In making your explorations, should you come across any body of pine or spruce timber, you will be careful to make a note of the locality, that is, the particular mile-post on the line near which the timber is situated, the character of the timber, that is, if it is large or small, if the trees are tall or short, and if it appears to be thrifty and sound, or the reverse, and over about how large an area it extends, also on what streams it is situated, and if they are tributary to James bay, lake Huron or the Ottawa valley waters.—Aubrey White.

"Instructions for geological work in connection with survey of line between Nipissing and Algoma: All outcrops of rock accessible within reasonable distances of the line on each side should be examined, special attention being paid to the boundaries of Huronian areas. The shores of lakes and rivers are most likely to afford satisfactory rock exposures. In Huronian areas search should be made for quartz veins, fahlbands and bosses of eruptive granite, samples being taken of quartz or other minerals likely to contain gold or other valuable minerals. Where the nature of the rock is doubtful, it is advisable to take samples of the country rock of sufficient size for determination. In general, every point that is of interest regarding the economic geology and mineralogy of the region should be carefully noted.—A. P. Coleman."

Mr. Alexander Niven, O. L. S., having been appointed to carry out the survey, left Toronto for that purpose on June 29, 1896. The writer, following instructions received from the Bureau of Mines, accompanied his party. After thirteen hours' journey by rail, Wahnapitae station a few miles east of Sudbury was reached, and the party encamped for the night. Next day a walk of 17 miles brought us to Wahnapitae lake, where our party, numbering fifteen in all, with its complete outfit of canoes and supplies, was finally assembled. The road from Wahnapitae station to the lake offers some points of geological interest in the deposit of sand and gravel over which it runs, and in which occur remarkable kettle-holes, so called, which are said to be about 300 feet deep. The extensive use made of narrow-gauge railways in lumbering operations may also be seen to good advantage here. Journey to the starting point of the line.

After visiting the old Hudson's Bay Company's post at the Indian reserve on the north shore of the lake, where a sketch map of our route was obtained, we left the western bay of Wahnapitæ lake on July 1, and proceeded by way of three small lakes, with intervening portages, to Marshy lake on the Vermilion river, which was reached on the 4th. The ascent of this river to the point where it crosses Proudfoot's East and West line occupied six days, although the distance is only about 30 miles, as a continuous series of rapids made it necessary to wade and tow the canoes for a large part of the way. Under these circumstances no geological work was attempted. The country traversed by the river on this part of its course has been geologically described by Dr. Bell.[1] Its southern part consists of volcanic breccia of doubtful age, north of which is a Laurentian area, at this point about seven miles wide, succeeded by Huronian rocks which extend beyond the point where the boundary line intersects the river. At several points extensive beds of boulders occur, probably moraines; the interstices in some cases filled with sand, in others not. The material seems to be mainly that of the rocks a little to the north, conglomerates and quartzites being common.



References to map sketches.

Work on the line was finally commenced on July 13, and continued with slight intermissions up to October 12. During this time a strip of country, 102 miles from north to south, and varying in width from one to seven miles, was examined. This tract traverses parts of the basins of the Vermilion, Wahnapitae, Montreal, Mattagami and Abitibi rivers, and hence crosses two important watersheds, namely, that between the lake Huron and Ottawa river systems, and that between the Ottawa and Moose river waters, as well as two minor ones between the Wahnapitae and Vermilion and the Mattagami and Abitibi rivers. The work was discontinued a few miles to the west of Night Hawk lake, a body of water about ten miles long by eight broad, whose waters flow northward to the Abitibi river. From this point the Hudson's Bay Company's route was followed through a part of the Night Hawk river and sixteen lakes of varying sizes to Fort Matachewan, situated near the great northern bend of the Montreal river. Following this stream to the southeast, Bay lake was reached after a journey of about 80 miles, and from a point on the river a little beyond this a series of portages with small intervening lakes brought us to Haileybury on lake Temiscamingue, completing a canoe journey of about 150 miles. Leaving Haileybury by steamer on October 21, Toronto was finally reached on the 23rd, after an absence of about seventeen weeks.

Region of country explored and traveled over.

[1] Geological Survey Canada, vol. V., part F., 1889-90.

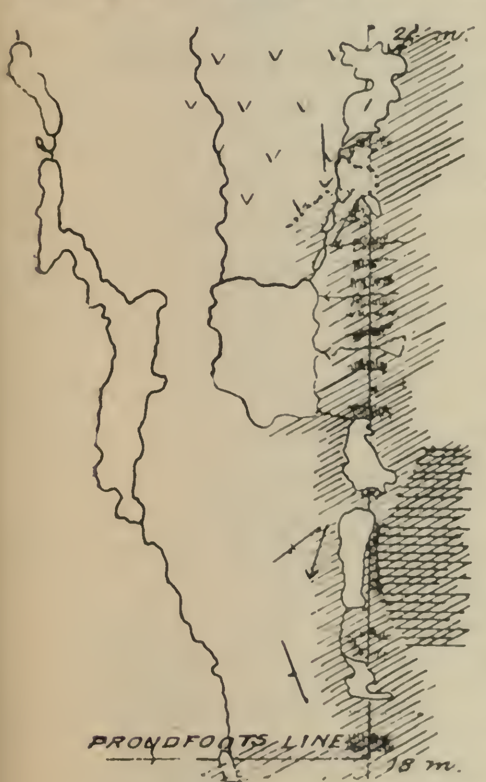
Acknowledgements.

An acknowledgement is here due to Mr. Niven's kindness during the summer in facilitating the geological part of the work. Dr. Coleman has rendered much necessary assistance in the determination of rocks, as well as in general suggestions as to the most advantageous methods of working. Dr. Dawson and Mr. A. E. Barlow of the Geological Survey have kindly furnished information regarding the geology of the district. To all these gentlemen the writer desires to express his gratitude.

LAKE HURON SLOPE.

The main Huronian belt

The main Huronian belt of this district, which runs in a northeasterly direction from the northern shore of lake Huron, curves to the north on reaching lake Wahnapitae and finally to the northwest, enclosing a Laurentian area within the elbow thus formed.



Following a northwesterly course from lake Wanhapitae, the southern boundary of the Huronian rocks crosses the Vermilion river at Blackash creek, and the boundary line between Nipissing and Algoma at a point about 12 miles north of the north-east angle of the township of Lumsden. Previous to the present year the district line had been surveyed to a point 18 miles north of Lumsden township, where it joins a line known as Proudfoot's base line, which runs from this point in a westerly direction. The iron post planted at the intersection of these lines formed the starting point of Mr. Niven's survey, and from it the line was run due north, astronomically. The commencement of our work was thus made at a point about six miles north of the southern boundary of the Huronian area, and with the exception of two areas of eruptive granite the entire length of the line was found to lie upon rocks which are considered to be of this formation.

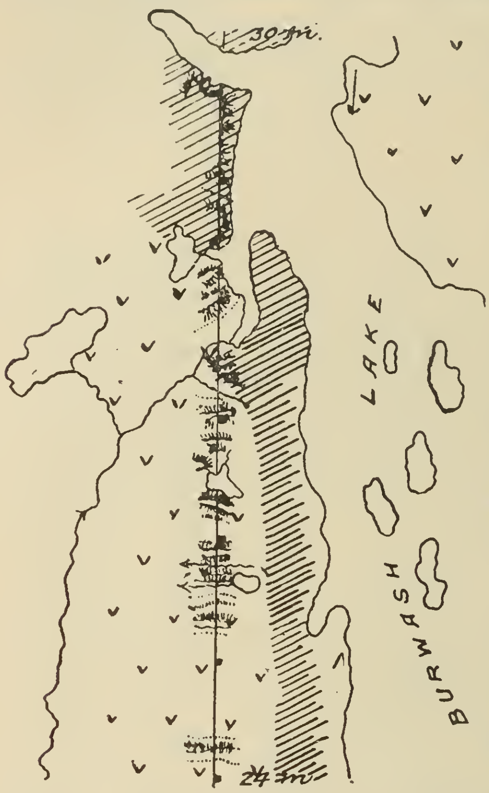
Starting point of Niven's survey.

A section of hills, rocks and lakes.

The watershed between the lake Huron and Ottawa river waters crossed the line at the 50th mile, 32 miles from our starting point. The country crossed by the intervening section of the line is of a hilly and rocky nature, containing a large number of lakes, and very scantily covered with a light sandy soil, which is in many places entirely absent. At many points a considerable amount of good white pine occurs, notably on the high ridge of quartzite hills which runs from east to west, crossing the line between the 30th and 40th miles. These hills are covered by a belt of timber some nine miles in width, and extending apparently for several miles east and west of the line. The trees are for the most part sound, tall, and from eighteen to twenty-four inches in diameter at the butt. A great part of the country outside of this belt, while

White pine areas.

containing occasional groves of white pine, is wooded with spruce, pitch-pine, balsam, birch, poplar and tamarac. Occasional maples were also encountered. Several moose and red deer were seen on the lake Huron slope, north



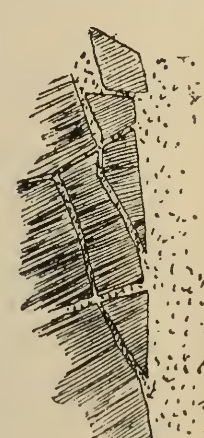
of which the latter do not appear to penetrate. Traces of both animals were abundant, and bears also appeared to be quite plentiful. The principal fish inhabiting the lakes are pike; one of these, caught in Welcome lake, proved more than sufficient to furnish a meal for fifteen men.

Fauna of the region.

Prevailing rocks along the line from the 18th to the 28th mile.

The rocks near the intersection of Proudfoot's base line by the Vermilion river are described by Dr. Bell as "quartzites, greywackes, argillites, and clay slates."[2] They strike northwest and southeast, parallel with the general trend of the formation, and dip to the northeast.

Following the line north from the starting point, the same varieties of rocks prevail. A conglomerate is first met with, and afterwards, on the shores of a small lake, a fine-grained greenish gray rock, probably an argillite. On the eastern shore of the second lake crossed, the line touches the western edge of an area of intrusive greenstone, which, after the line leaves it, extends for some distance to the northeast. At the southern end of this lake the rocks dip to the southwest, the strike remaining about northwest and southeast. On the western shore however the strike makes an abrupt curve to the northeast, perhaps due to the presence of an area of hornblende-granite, the boundary of which is reached on the north shore of a small lake crossed by the line about four and a half miles from our starting point. On the north shore of this lake the Huronian series is represented by a conglomerate containing pebbles of granite. This is followed a little further north by the granite. This granite area has a width of about five miles where crossed by the line, broken by a tongue of Huronian rocks which enters it on the eastern side near its southern extremity and occupies the southern shore of a small lake on the 24th mile (sixth mile from Proudfoot's base line). At this point also the rocks immediately in



Contact between granite and Huronian (?) rocks, 27th mile. Huronian on the left; granite on the right.

contact with the granite are conglomerates. The strike of the Huronian rocks in the vicinity is deflected and follows a course parallel to the outline of the granite area. The granite seems to be undoubtedly an intrusive mass, judging both from the character of the rock, which is a massive reddish hornblende granite, generally coarse-grained and often porphyritic, and from the fact that

Intrusive granites and Huronian conglomerates.

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[2] Geological Survey Part F. Annual Report, Vol. V., 1889-90.

the Huronian rocks near the contact are shattered and the crevices penetrated by the granite. Several small veins of rusty quartz were observed in the Huronian conglomerates near the contact, one of which on assay yielded a distinct trace of gold. Within the granite tract a small area was observed made up of coarsely crystallized hornblende.

First show of gold.

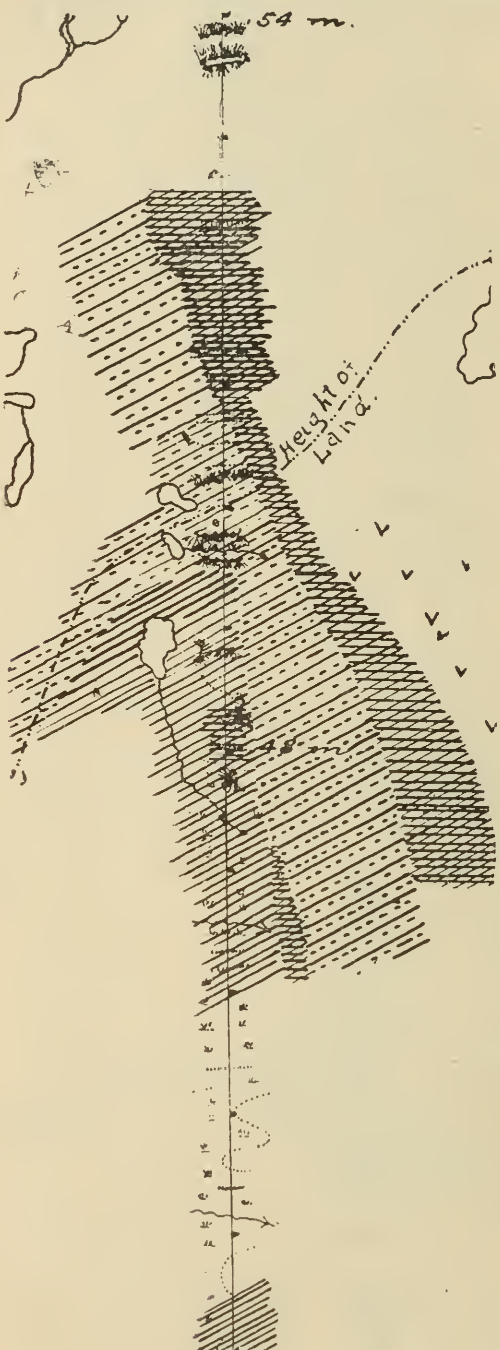
On the 28th mile the line emerges again upon a tongue of Huronian conglomerates, which extends to a large creek flowing into the southwestern bay of Burwash lake. On the western shore of this bay the granite is again met with, but is finally lost sight of at its northwestern corner. Here, as before, it is immediately succeeded by a conglomerate, which in this locality contains rounded boulders of gneiss nearly a foot in diameter. Conglomerates and massive, somewhat crystalline rocks occupy the western shore of the lake north of this point. Half a day was spent in examining the shores of the northern end of this lake, which appears to be about six miles from north to south, with a maximum width from east to west of perhaps three miles. Its eastern shore so far as examined consists of red granite, which extends to the northeastern corner of the lake. The entire northern shore of the main portion of the lake and also that of its northwest arm is occupied by massive white quartzites or sandstones, which in some places have the texture of grit, and contain frequent bands of pebbles, giving the rock in such places the character of a conglomerate. The disposition of these pebble bands is the only indication of the original bedding of the rock. The present planes of cleavage are quite independent of the bedding, and often run in more than one direction. The only quartz met with in the vicinity of Burwash lake was a twelve-inch vein in a small Huronian area which interrupts the granite on

Around Burwash lake.

the eastern shore of the lake. It is not of particularly promising appearance. The waters of this lake flow to lake Huron by way of the Wahnapitae river.

An area of quartzite or sandstone from Burwash lake to the 40th mile.

Following the line northward, the quartzite extends nearly ten miles, forming a high ridge of hills, which runs in a general northwest and southeast direction, following the general strike of the country. They are penetrated along the shores of Welcome lake and the lake immediately west of it by several areas of diabase, and on the western lake a few beds of fine-grained clayey sandstone and greywacke conglomerate also occur which strike 51° west of north and dip to the southwest at an angle of about 25°. From this point north as far as the 40th mile the rocks are of the same description as those already referred to on the north shore of Burwash lake. Throughout this area of sandstone or quartzite no indications of metalliferous deposits were observed, but the rock may perhaps in some places furnish a good building-stone.



Valley of the Upper Wahnapitae river, from the 40th to the 50th mile.

On the 40th mile the line passes off the massive sandstones, and the level of the country at the same time sinks from the lofty ridge formed by them to a broad undulating level, largely covered by a deposit of sand, through which the waters of the Upper Wahnapitae river follow a winding course. This valley is flanked on the east and west for some distance north of the point where the line enters it by quartzite hills which p ct like buttresses from the main range. A spur of one of these ridges touches the line at the 41st mile, and the band to which it belongs apparently runs parallel to the line on the east side for nearly ten miles, crosses it at the watershed on the 50th and 51st miles, and finally unites with a similar band on the western side of the line. The area thus enclosed by the sandstones forms the floor of the valley just described. It is largely covered by a deposit of sand from two to ten feet in thickness, and the underlying rocks are only occasionally exposed. In several places ridges of diabase

and of diorite or altered gabbro rise above the level of the swamps and sandflats which cover the surface, and apart from these the underlying rocks seem to consist of crushed felsites, fine-grained sandstones and conglomerates. The strike on the 43rd mile is about 4° west of north, and the rocks here lie in almost level beds. At a distance of two or three miles east of the 49th mile post an area of red hornblende granite is met with, but owing to the distance from the line and want of time it could not be very thoroughly examined. It contains inclusions of what appear to be Huronian rocks, considerably altered.

Owing to the amount of soil on the surface and to the absence of lakes on whose shores large exposures might occur, only a very imperfect idea could be obtained of the geology of this section of the line, from the 40th to the 50th miles, and no quartz veins or other indications of the presence of economic minerals were seen.

BASIN OF MONTREAL RIVER.

The line passes over the watershed between lake Huron and the Montreal river near the head waters of the western branch of this river, and traverses its basin at a point where it is only 26 miles wide on a north and south line. Throughout this distance the line is over a level country, rising at intervals on low rocky ridges. The soil is sandy, and toward the southern side of the basin is in places of considerable depth. The principal timber is pitch pine, which grows to a height of about 70 feet, with a diameter at the butt of from ten to fifteen inches. The woodland is quite frequently interrupted by hay-marshes, muskegs, and marshy lakes. Occasional rocky ridges are covered with a growth of red and white pine, and a few large poplars fringe the open spaces. There are several freshly burnt areas, and others in which the trees are probably not much over 25 years old.

Features of the Montreal basin where crossed by the line.

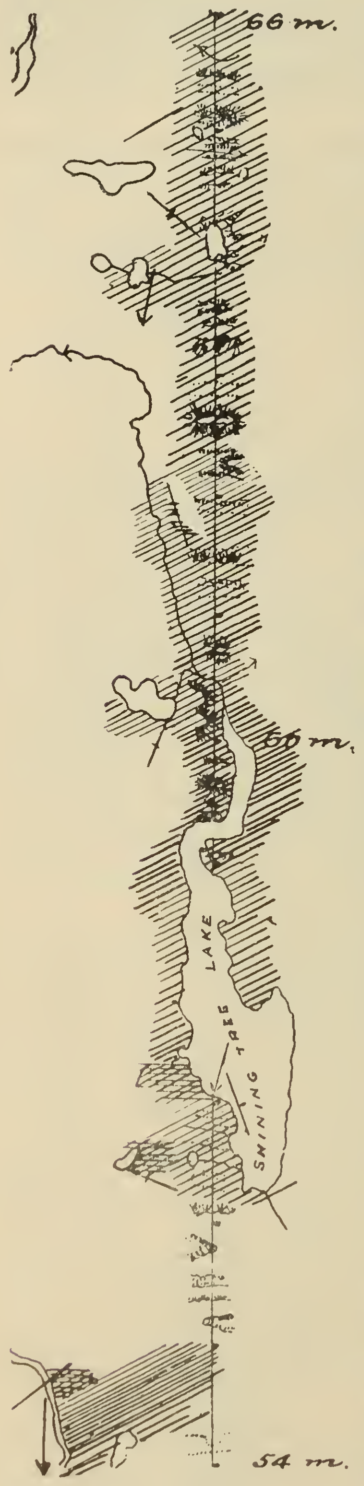
After crossing the line at the 51st mile the band of thick-bedded sandstones already described extends in a northwesterly direction and appears to pass to the west of the Montreal river. It is succeeded on the north by a series made up mainly of quartz-diabase, gray ash-rocks and chlorite schists. The Montreal was reached on August 19 at a point about a mile and a quarter west of the 55th mile. The country at this point is largely covered with sand deposits and muskeg. An outcrop occurs on the 53rd mile, and the rock here is apparently a diabase, and contains much pyrites. The compass is strongly affected when brought near the rock. On the banks of the river the rock is a fine grained quartz-diabase, and a similar variety of rock appears on the canoe route running west from Shining Tree lake on the 57th mile.

Nature of the rock formations.

On the southwestern shore of Shining Tree lake a small band of conglomerate is exposed, which however extends only a short distance from the shore. On the western shore of the lake quartz diabase is met with, and for some distance south along the line a massive fine-grained gray clastic rock occurs, apparently a volcanic ash. The strike of the rocks at the southern end of the lake is about 16° west of north. On the north shores of the lake gray

Shining Tree lake

weathered diabase or ash rock, chlorite schists and conglomerates are the predominating rocks. A peculiar gray amygdaloidal rock with angular inclusions of a lighter color was observed on the east shore of the northern arm. The amygdules are very small, and consist of calcite. The main body of the rock appeared to be a chlorite schist. The rock as a whole may be a very much weathered amygdaloidal diabase. On the northwest side of the entrance to the north bay the strike varies from the normal direction of the neighborhood (N. 20° W.) to about north 40° east. On the southeast side of the entrance it is about N. 40° W. (dip E.) and on the east shore of the northern arm of the lake about N. 75° W. At several points on the shores of this lake veins of quartz, calcite and felspar occur. The most important is on the shore of the northern bay. It is about 15 inches in width and carries a good deal of pyrites. An assay made by Mr. James of the School of Practical Science showed a slight trace of gold.



Second show of gold.

Northwest of Shining Tree lake, and at a distance of about half a mile from it, a small lake was found whose waters discharge into the same stream which forms the outlet of the larger lake. The rocks on its shores are apparently volcanic ash, and strike N. 25° E. A small quartz vein containing calcite was noticed here. The creek flowing out of Shining Tree lake crosses the line about the middle of the 61st mile, and makes its way north and west to the Montreal river. A little over a mile north of the crossing the line touches the end of a bed of jasper which extends from this point (61 m. 53 ch.) northwest for a distance of over half a mile. At the point where it is first met with the jasper rises in a low ridge from the soil of a swamp, and is in a comparatively solid condition. It is interbedded with thin seams of iron ore. Further north the ground rises and the band can be traced without great difficulty. It is greatly weathered however, and its presence is indicated on the surface only by broken fragments of rock, so that it is impossible to say whether any considerable quantity of ore is contained in the jasper or not. At the widest point the bed is about 100 yards broad. On the line to the east of it the needle is deflected west about 18°, while the average variation for the locality is only about 7° west. The jasper is red and black in color, often banded. The percentage of iron in a badly-weathered specimen of the ore was 47.26.

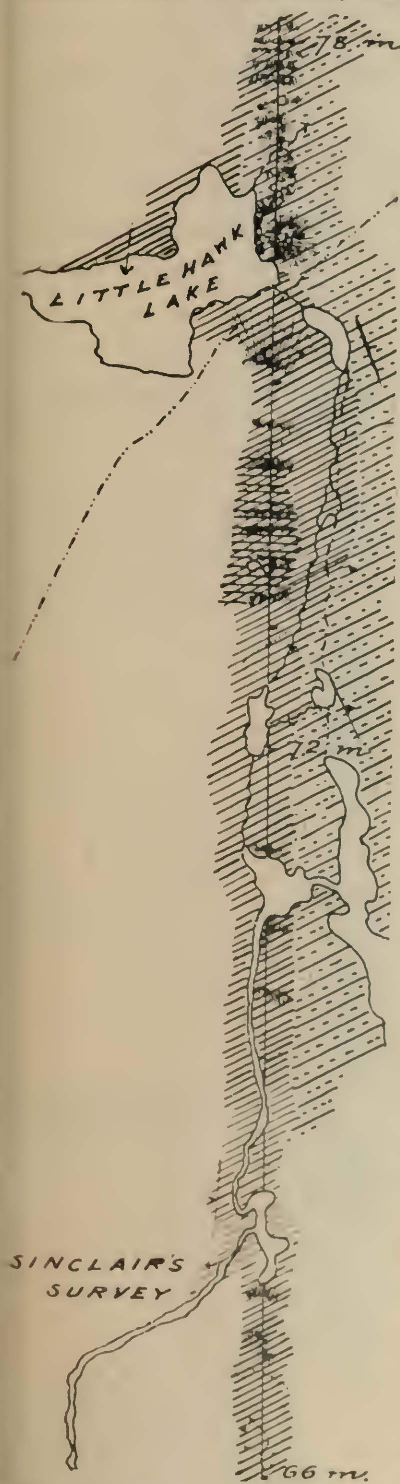
A band of jasper, with seams of iron ore.

Percentage of iron in the ore.

To the west of this jasper deposit the rock is apparently a somewhat coarse-grained diabase, followed after a short distance by a fine-grained ash rock, which becomes a conglomerate a little further west, containing fragments of jasper, granite and quartz. The strike of these beds is parallel to that of the jasper—namely about N. 15° W.; the dip is to the west at an angle of about 75°.

An area of massive ash rock, succeeded by fine-grained clastic rock.

Proceeding north along the line, a massive fine-grained rock was encountered, apparently ash, penetrated in all directions by small veins of a light green material, probably serpentine or epidote. This is followed on the 62nd and 63rd miles by a greywacke conglomerate. On the shores of a small lake about half a mile west of the 64th mile post a twenty-inch quartz vein carrying pyrites was found, but yielded no gold on assay. A massive, fine-grained, greenish-gray ash forms the prevailing rock of this locality, and in fact of the entire district as far north as the crossing of the Montreal river.



Just north of the lake expansion at which the line strikes the river, and a little east of the line itself, the rock now described gives way to a fine grained clastic rock of reddish color, apparently a crushed granite. This lies in somewhat thick beds, striking in a general north and south direction and dipping about 20° towards the east. It sometimes alternates with beds of a dark greenish-gray rock of slaty appearance. Both varieties occasionally include rounded pebbles and boulders of granite, in places passing into a boulder conglomerate, in which some of the included masses have a diameter of about two feet.

The Montreal river follows the line north along the strike of the rocks for about three miles, then bends to the east and south and widens into a long, narrow expansion known as Pigeon lake, which extends along the strike of the rocks southward and nearly parallel to the former course of the stream. The boundary between the two varieties of rock above described runs north and south between the two arms of the V-shaped loop of the river, crossing it at the head and extends in nearly the same direction as far as Night Hawk lake. The line lies within the gray ash-rocks, which dip to the west. The crushed granites and slaty rocks are exposed on the shores of Pigeon lake.

Quartz veins, with calcite and serpentine.

Along that part of its course in which the river runs close to the line several small veins of quartz were noticed. These contain a considerable amount of calcite and serpentine. The latter mineral also forms small veins at some points. North of the bend the line runs over gray ash-rocks as far as Little Hawk lake, with the exception of an area of weathered greenstone, which occupies part of the 74th and 75th miles.

HUDSON BAY SLOPE.

General description of the watershed.

From the northern end of Pigeon lake a short canoe route runs through three small lakes, connected by portages known as the Little Hawks, to the larger body of water named Little Hawk lake. A short and level portage, the most northerly of the Little Hawks, crosses the watershed between the St. Lawrence and Hudson Bay systems. A lofty hill of reddish rock situated on the east shore of Little Hawk lake and visible for a great distance seems fittingly placed to mark the divide.

The waters of Little Hawk lake flow west by the Grassy river into the Mattagami, which also receives the outlets of the lakes as far north as Moose lake. Beyond this point all the streams flow north to Night Hawk lake, and so eventually into the Abitibi river.

Timber of the region.

The timber north of the watershed is mainly spruce, birch, tamarac and poplar. A few ridges between Little Hawk lake and the Grassy river are covered with a growth of large white pine, and small areas of red pine occur on the shores of the river itself. On the shores of Moose lake the spruce forest is composed of trees from twelve to sixteen inches in diameter and from 80 to 100 feet in height. In the vicinity of Mount Sinclair a few very large white pines are found, but the woods are mostly birch and poplar. Some pitch-pine of fair size occurs in several localities. Towards the northern end of the line, and in the vicinity of Night Hawk lake, the sand and clay flats are wooded with large poplar, birch, spruce, and tamarac. The amount of cedar in the country is small.

Sinclair's exploration line.

An exploration line surveyed by Duncan Sinclair, P.L.S., in 1867, beginning near the great north bend of the Montreal river, runs westward in lat. 47° 56′ north towards lake Superior, and intersects Mr. Niven's north and south line near the 86th mile-post. It crosses the watershed at Mount Sinclair, a lofty elevation of a similar character to the hill at Little Hawk lake.

A noon halt near Bay Lake.

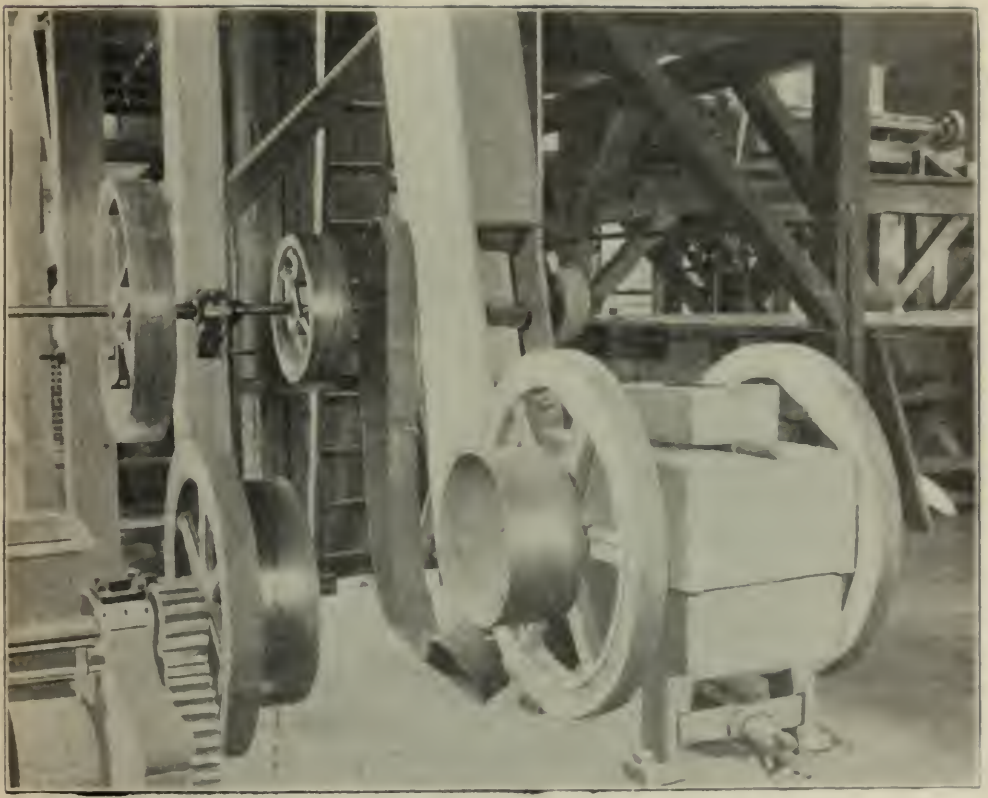
Summer residence of Chief Buffalo, Nighthawk lake.

A jackfish caught in Welcome lake.

Homeward bound between Bay lake and Temiscaming lake

Mount Sinclair. Highest land in Ontario.

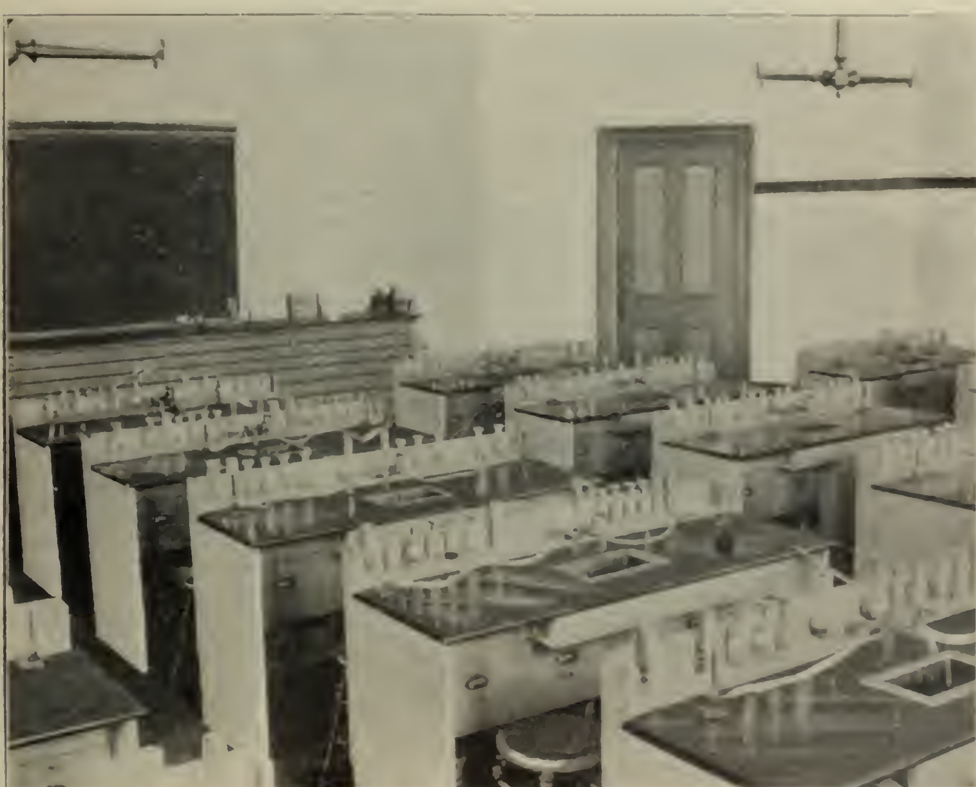
School of Mining, Kingston. John Carruthers Science Hall to left and Mining Laboratory to right.



School of Mining, Kingston. Mining Laboratory, showing Rolls to left, Crusher in centre and Frue Vanner to right.

School of Mining, Kingston. Chlorination Barrel and Tanks

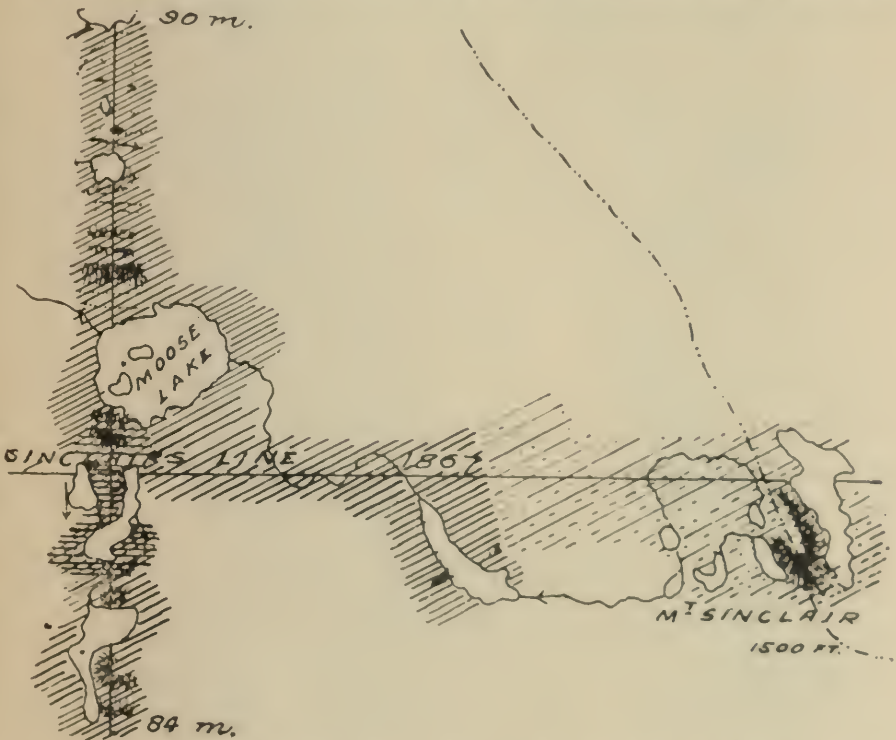
School of Mining, Kingston. Furnaces of Assay Laboratory.



School of Mining, Kingston. Laboratory No. 3

Mount Sinclair, probably the highest point of land in Ontario.

Mr. Sinclair estimates its height at 1500 to 2000 feet. As the surrounding country lies at an elevation of about 1000 feet, this calculation would place the top of Mount Sinclair from 2500 to 3000 feet above sea-level, the highest point known in Ontario. Its distance from our line is only about five and a half miles, and it was thought desirable if possible to visit it. Owing however to a delay in locating Sinclair's line, only a day could be devoted to this purpose, which proved too short, as the country is difficult to traverse. After travelling about six and a half hours a point about two and a half miles from the mountain was reached and a fair view obtained. At this distance its height does not appear to exceed a thousand feet. In common with other large hills in this neighborhood, it consists of a mass of reddish rock, similar to that



on Pigeon lake, which has resisted erosion. In form it is a ridge running in a north and south direction. It is terminated at the south by a series of perpendicular cliffs, while the ascent at the northern end is gradual. A photograph illustration shows the character of the surrounding country. In the foreground is a creek which runs westward into Moose lake, and part of a small lake which it drains.

Soil and drift

The soil as far north as Kitchimene lake consists entirely of sand, and lies very thinly upon the rocks. From this point on however its depth gradually increases, and from the 100th mile-post rock exposures occur only occasionally. From about the 100th mile northward the sand overlies a layer of bluish clay, and at the 108th mile the total depth of the drift is about 40 feet. On the 109th mile the sand disappears and the soil is largely clay from this point to the end of the line, at the 120th mile. Around Night Hawk lake level clay land reaches as far as one can see. It is often covered by several inches of black mould, and should make an excellent agricultural district. The Indians who live at Night Hawk lake grow potatoes, but apparently nothing else.

Fauna of the Hudson Bay watershed.

North of the Hudson Bay watershed few red deer are found, but moose and caribou are numerous. Bears are also present in considerable numbers, and beaver are not infrequently met with. A beaver-dam crossed on the route to Mount Sinclair was about 200 feet long and from one to four feet high. Gray "mountain trout" from one to four pounds in weight are found in some of the lakes.

GEOLOGICAL DESCRIPTION.

Rocks of Little Hawk lake and Grassy river.

At Little Hawk lake the reddish thick-bedded rocks met on Pigeon lake

and the Little Hawks cross the line and occupy the east shore of the lake. North of the lake they turn eastward again, and their boundary recrosses the line at the 78th mile. They are succeeded on the north by a greenish gray conglomerate, and this is in turn followed by gray ash-rocks, which in places give way to what appears to be an amygdaloid, the light colored amygdules of which weather out at the surface. The ash rocks also occupy the western part of Little Hawk lake [3], and the conglomerate appears at points along the north shore, between the reddish rocks and the ash. Following the Grassy river northeast from the outlet of Little Hawk lake, the greenish ash rocks are occasionally exposed on the river and quite largely on the small lakes into which it expands. The line crosses the Grassy river on the 81st mile, at the second lake above Little Hawk lake. The strike on this lake is nearly north and south, and the dip east about 45°. The rocks contain a considerable amount of calcite, which in places forms small veins. On the north shore of the lake crossed by the line a small bedded quartz-vein was noticed, and to the south, on the 79th mile, a number of stringers occur. At the eastern end of the lake, east of the line, a quartz-vein about three feet wide crosses a small bay on the southern shore, and a band of the country rock on the

3 See Geological Survey of Canada, Report of Progress for 1875-76, pp. 305-306.

same bay is heavily charged with pyrites. The quartz has no indication of carrying valuable metals, and an assay of the mineralized band failed to show the presence of gold. The strike on this lake changes from about north and south to nearly east and west; the dip is to the north.

About two miles north of Grassy river a small area of reddish crushed granite or felsite similar to that at Pigeon lake is crossed, and is succeeded, as at Little Hawk lake, by a greenish conglomerate. The country along this part of the line is largely sand-covered. On the shores of a small lake on the 84th mile a sericite-dolomite-schist is exposed. The lake opposite the 85th mile has exposures of schistose rocks considerably stained with iron. Several small quartz veins occur in these rocks, one of which was assayed, but yielded no gold. The strike on the 84th mile is N. 40° E., and the dip is vertical.

Third show of gold.

The lake which lies almost at the intersection of Sinclair's line is surrounded by what appears to be weathered diabase, greenish in color, and containing small cubes of pyrites. Calcite is also present. The small lake immediately west lies upon similar rocks. Some distance east of the line, about two and a half miles west of Mount Sinclair, the reddish thick-bedded rocks of Pigeon and Little Hawk lakes are again met with, and the mountain itself seems to be a repetition on a larger scale of the hill at Little Hawk lake. Just west of the contact, a band of fine-grained clastic rock, containing some chlorite and heavily charged with pyrites, is exposed on the sides of a small ridge. An assay of this rock shows the presence of gold in small quantities. Several small quartz veins were also noticed in this neighborhood.

Fourth show of gold.

The rocks on the south and west sides of Moose lake are similar to those on the lake to the south. The north and east shores are low and sandy. North of this lake for several miles the country is largely sand-covered, and only a few exposures of greenish, badly weathered rocks were seen. On the lake to the east of the 92nd mile a weathered diabase with crystals of pyrites is exposed at the narrows. Grayish rocks (perhaps ash) showing a tendency to schistose structure in places, and containing some chlorite and calcite, were met with at the northern end of the lake, and on the shores of Kitchimene lake. At the 92nd mile post a chlorite schist heavily charged with pyrites occurs, and an assay of a sample of it shows a trace of gold.

The rocks on the two lakes just mentioned strike in a northwest and southeast direction, but just north of Kitchimene lake, on the 96th mile, the strike is N. 87° W., and from this point the strata curve to the northward, following the boundary of a granite area which is entered by the line near the 97th mile post. Just south of the contact the line crosses a small area of diabase. The Huronian rock at the contact is a hornblende schist, and is penetrated by the granite in small veins. The granite at the contact is very fine grained, but a short distance north it becomes coarser, and is throughout the area a somewhat coarse-grained, reddish, porphyritic hornblende granite in places, approximating to syenite. On the trail which runs east from the intersection of the line by the river on the

99th mile, the boundary of the granite lies about a mile and a half east of the line. The Huronian rock at the contact is a greenish altered sandstone. About two miles further east a quartz vein was noticed, but was found on assay to contain no gold. The Huronian rocks at the contact dip to the west, or towards the granite. The line leaves the granite on the 104th mile, where an outcrop of grayish sandstone occurs. From this point on exposures of rock are rare, owing to the depth of soil, and the boundaries could be only approximately determined. To the east of the 106th mile reddish slaty rocks and diorite schists were found. At a waterfall near the 106th mile post a greenish gray chloritic rock is exposed.

Huronian and granite contact.

The boundary of the granite, after crossing the line, turns northward, and is seldom distant more than a mile to the west for about eight miles, when it again inclines to the east and crosses the line at the 111th mile. At a point about a mile west of the 109th mile post several quartz veins occur in the granite, but are barren of gold. About 30 chains west of the 113th mile a small area of diabase occurs, which apparently lies within the granite area. To the east of the 115th mile what appears to be a similar area was found. About one mile east of the line at this point the granite gives way to Huronian rocks. The outcrop noticed here consists of silicious dolomite.

Fifth show of gold.

Near the end of the 116th mile the line finally passes off the granite, and enters upon grayish slaty rocks. On the first half of the 116th mile a small quartz vein occurs which on assay was found to contain a trace of gold. On a trail which runs northeast from the 115th mile some outcrops of grayish gniess occur at a distance of about three miles from the line. At the crossing of the Redstone river, on the 117th mile, the rock exposed was a greenish weathered diabase. North of this point no outcrops were observed on the line. The survey was finished at the 120th mile post.

Redstone river.

From the 120th mile the Redstone river (Neminisebe) runs eastward to Night Hawk lake. The shores of the river and lake are occupied by banks of clay, but the underlying rocks wherever exposed appear to be Huronian.

The district would be a promising one from a prospector's point of view were it not for the presence of the drift.

Night Hawk lake.

The waters of Night Hawk lake flow northward into the Abitibi river by a stream whose Indian name, literally translated, means 'Hollow Sand river,' probably referring to the nature of the soil through it flows. The name Night Hawk lake is a translation of the Indian Pèshkacagamingue. An island in the lake is the permanent residence of several families of Indians, and a small trading post belongin to a trader named Angus McLeod is situated on the northwestern shore. The price of flour at this point is $20 a bag, and other articles are correspondingly dear.

DRIFT AND GLACIAL GEOLOGY.

Record of glacial striations.

During the summer the bearing of glacial striations was noted wherever possible, and the following is a list of the readings, corrected as nearly as possible to represent the astronomic bearings :

	Degrees.
Marshy lake (Vermilion river)	18
Lake on 20th mile, west shore	12
Lake on 23rd mile, west end	347
Burwash lake, east shore	353
Lake 2 miles west of 31st mile	353
Ridge east of 32nd mile	353
Welcome lake, east shore of south bay	352
Lake on 35th mile, ½ mile west of line	353
Montreal river, elbow west of 55th mile	4
Shining Tree lake, south bay	1
Shining Tree lake, south shore near line	16
Small lake ½ mile west of 64th mile	16
Little Hawk lake, west arm, north shore	7
Lake crossed on Grassy river, southwest end	8
Lake crossed on Grassy river, northeast bay	18
Small lake east of 82nd mile	8½
Small lake on Sinclair's line	1½
Kitchimene lake	8½
Night Hawk lake, mouth of Night Hawk river	343

It will be seen that where the successive readings show a considerable change in direction the intervening space is generally a long one. An exception occurs at Shining Tree lake, where a difference of 15° is found within a few hundred yards, and may represent two sets of striations. The greatest difference is 35°, from N. 17° W. to N. 18° E.

Markings on the quartzites.

The thick bedded sandstones or quartzites which cross the line between the 30th and 40th miles preserve the glacial markings better than any others observed, and the readings taken on this section of the line are almost uniform. These rocks and the crushed felsites or granites of Pigeon lake, Little Hawk lake and Mount Sinclair, have been indicated on the map by alternate dotted and continuous lines. They appear to resist the action of ice and other erosive forces better than any others. The quartzites almost invariably form high continuous ridges, and the crushed granites are marked by the presence of large isolated hills, of which Mount Sinclair is the most conspicuous example. A study of the map shows that the presence of these rocks often marks the position of water-sheds, owing apparently to the more yielding rocks on each side having been worn away by erosion. They thus exert a determining influence on the course of rivers and the topography of the country generally. Mount Sinclair and the large hill at Little Hawk lake both present a gradual slope towards the north, due to the action of ice, and both are precipitous on the southern side.

Resistance of the quartzites and crushed granites to erosive forces.

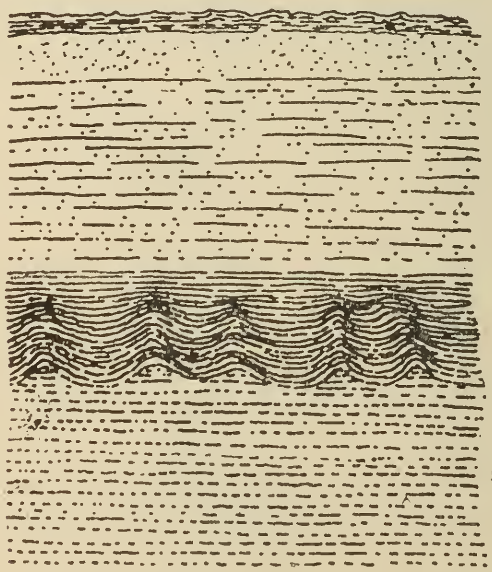
Evidence of ice-shaping on granite hills.

Moraines.

Large boulder-beds, apparently moraines, occur on the Little Hawk portages, just south of the mountain at Little Hawk lake, and at the point on the 99th mile where the line crosses a small river. The materials of these and the boulders noticed throughout the district belong to the rocks some miles further north.

An ancient river gorge in the quartzite hills.

The high range of quartzite hills between the 30th and 40th miles, already described, is traversed from north to south by a gorge which seems to have been cut by a stream much larger than the brook which now runs through it. The peculiarly shaped western bay of Welcome lake, into which it opens, seems to be an expansion of it. From the southern end of this bay a similar valley continues southward to Burwash lake, its bottom being filled with drift, which may be a further continuation of it.



Section of sand deposit on bank of Upper Wahnapitae river (41st mile). Total thickness, 10 feet.

Evidence of a filled lake basin on the Upper Wahnapitae.

The valley of the Upper Wahnapitae river, and the wide flats and swamps which form the height of land just north of it, are covered by a deposit from three to ten feet deep of yellow and gray stratified sand, separated by a band of sandy clay. On the surface is a layer of very fine white sand mixed with shells of infusoria. The finely-stratified grayish sand which forms the lowest bed in the deposit is undulating in outline as seen in section at the top, which was apparently a ripple-marked surface. The laminæ of

the clay above follow the undulations at first, but gradually straighten out and are horizontal at the top, where they give way to a reddish-yellow sand marked by streaks of iron rust running in the direction of the stratification. The neighborhood appears to have formed the bottom of a lake, which afterwards grew shallow and finally dried up, or was drained by the lowering of its outlet. The lake west of the 42nd mile may be a remaining part of it.

Post-glacial drift on Night Hawk lake, and southward to Montreal river.

Around Night Hawk lake a finely-stratified, yellowish-gray clay is exposed in banks from ten to twenty-five feet high. Following the line south from this point the clay continues on the surface for about eleven miles, when it is overlaid by sand and gradually thins out. The sand in its turn decreases in thickness and does not form a continuous deposit south of Kitchimene lake.

The country passed over on the route from Night Hawk lake to lake Matachewan is covered largely by a deposit of sand and gravel, but no opportunity was afforded of examining a section. At several points along the Montreal river below Fort Matachewan banks of stratified sand and gravel, sometimes from 30 to 40 feet high, were noticed in passing.

CONCLUSION.

Relations of the country rocks.

The massive thick-bedded quartzose grits and crushed granites which have been described as occurring in several localities are considered by Mr. Barlow of the Geological Survey, who is familiar with many parts of this region, as forming the highest member of the Huronian formation in this area, and they appear from their position and occurrence to be distinctly higher than the fine-grained ash rocks, chlorite and dolomite schists, altered sandstones, slates, greywackes and conglomerates which are the prevailing rocks in the remainder of the area. So far as the researches of the past summer show, these newer rocks contain no indications of valuable minerals. In the lower part of the series, on the other hand, gold appears to be quite widely distributed, both in veins, which are of tolerably frequent occurrence, and in mineralized portions of the rock itself. Out of a total of eleven specimens assayed, five contained gold in small quantities, and the points from which these were taken extend from the fifth mile to the 116th, practically covering the whole of the region examined. In two cases the veins were situated near the boundary of granite areas. In two localities, between the 85th and 95th miles, the gold occurs in mineralized bands of the country rock, which in both cases is more or less chloritic. The distribution and character of rocks containing gold may be gathered from the following list:

Occurrences of gold, and distribution and character of the rocks containing it.

1. Small vein near boundary of granite area on fifth mile. Country rock apparently a greywacke conglomerate.

2. North bay of Shining Tree lake, 60th mile, in a vein of quartz containing felspar and calcite. Country rock, chlorite schist.

3. East of line near Mount Sinclair, opposite 86th mile, and near boundary of higher rocks. The gold occurs in a heavily mineralized band of fine grained clastic rock containing chlorite.

4. At 92nd mile post gold occurs in a chlorite schist, heavily charged with pyrites.

5. At 116th mile, a short distance from boundary of granite area, in a small vein containing some calcite. Country rock not determined.

Indications of valuable iron ore deposits.

The lens-shaped deposit of jasper and iron ore which occurs just north of Shining Tree lake indicates the probability of the existence of valuable deposits of iron ore within this area. No indications of the presence of copper or nickel were met with. In this connection an extract from Dr. Bell's report of his exploration of the Montreal river is of interest :

Quartz veins on the east branch of the Montreal river.

"At a distance of about ten and a half miles by the stream from the junction of this (east) branch with the main Montreal river, these rocks are traversed by a belt of quartz veins spreading over a breadth of a quarter of a mile. These veins vary in size from mere strings up to a width of thirty or forty feet. They run s. 70° e. and n. 70° w., and were traced for two miles west of the river, in which direction they show a tendency to converge. Some of the large ones have in places a brecciated character, holding fragments of syenite and slate. The majority of them contain more or less bright crystalline specular iron, and in some I found promising indications of copper pyrites."[4]

An extensive hunting ground.

Climate of the region.

The country passed over during the season is uninhabited in summer, but in winter is used as hunting-grounds by the Indians of lake Wahnapitae, Mattagami, Matachewan, Night Hawk lake, and other places. The climate corresponds with that of the lake Temiscamingue district. A light snowfall occurred on September 19 at Kitchimene lake. At Night Hawk lake on October 12, and during the journey down the Montreal river, the air was frosty, especially at night, and the weather for the most part fair and bright, much like fine November weather in southern Ontario.

[4] Geological Survey of Canada, 1875-76, p. 301.

SECTION VI.

MOSS LITTER.

Agriculture and Mining are the chief members of a group of arts which lie at the base of all others; without which, indeed, none others could exist. Agriculture supplies the primal necessities of man by giving him food and clothing, and both together furnish him with the raw materials for that wonderful and complex series of manufactures with which his ingenuity strives to gratify his tastes or satisfy his wants—tastes and wants which enlarge with his expanding civilization. They have both the same arena, the capacious bosom of Mother Earth, and both strive to turn to advantage the substances which nature there has placed. One enlists in her service those vital forces which draw the atoms of inorganic matter from air and soil, and which raise them from the mineral into the vegetable, and from the vegetable into the animal kingdom; the other deals directly with the mineral substances themselves, and by the mere act of changing their situation and separating them from one another, rescues them from inutility and makes them subservient to the wants of man. One may be called an adaptive industry, whose processes, if rightly conducted, move in a circle, and appear capable of being carried on for all time; the other may be termed a destructive industry, concerned with large yet strictly limited quantities of material, which once brought into play are forthwith made subject to decay and waste, and are scarcely, if at all, capable of being restored to their original condition. Agriculture and Mining touch each other at many points. The farmer feeds and clothes the miner; the miner warms the farmer, supplies him with fertilizers, keeps him in ploughs and harrows, and puts gold and silver in his purse. No market is worth so much to the tiller of the soil as a mining camp in full blast. Miners usually want the best, and are quite willing to pay for it. Agriculture and mining.

There are processes performed on the surface of the ground which in their nature seem intermediate between agriculture and mining, and to partake of the character of both. One of these is the reclamation of peat bogs and the utilization of the material of which such bogs are composed. As agricultural operations, such processes restore to cultivation considerable areas of land previously lying waste and barren, while viewed as incidents of mining, they convert to man's use actual portions of the earth's crust unchanged except by a certain amount of manipulation. Reclamation.

THE SPHAGNUM MOSS, AND ITS VALUE AS LITTER.

The origin of peat bogs is well understood. They are found chiefly in the colder parts of the globe, where evaporation goes on less actively than in the more tropical regions, and occur in low situations or where some natural or artificial obstacle impedes the drainage. The abundant moisture favors the Origin of peat bogs.

Structure of the sphagnum moss, and the process of conversion into peat.

growth of a low order of plants, such as the sphagnum mosses, of which some fifty or sixty varieties are known. This plant is distinguished above all others by its capacity for absorbing and storing water, for which its peculiar structure eminently fits it. The epidermis of the stalk and the leaves of the plant are mainly composed of large, empty cells, into which the water is drawn through a number of small holes. The cells are provided with ring or spiral-formed thickenings on their inner sides which keep them from collapsing. They are consequently always distended, and always ready for use. Smaller cells occur between the larger ones which contain chlorophyl and supply the plant with nourishment, but these occupy comparatively little space. The whole arrangement is that of an aggregation of reservoirs in successive layers, which are kept filled by the force of capillary attraction even when the plant itself is above the water level.

It is curious to note that the properties of the sphagnum moss, which render it so well adapted for living in a low and moist situation, tend also to bring its existence to an end. It requires a constant supply of moisture, yet it is continually pumping up to the surface of its tufts the water in which it stands, thus promoting evaporation, while at the same time by regularly decaying at its roots it deposits the detritus which adds to the solid contents of the bog. This process continues until the bog is raised above the level of the surface water, when the sphagnum vegetation ceases, having exhausted the conditions which made it possible. In this way bogs of considerable depth are formed in process of time. As the moss increases, decomposition takes place in the lower portions, which become consolidated into a black or dark-brown earthy substance that in various parts of the world is extensively converted into fuel. The usual method of utilizing it as such is to dig up the peat in cakes or blocks and dry them by exposure to the wind and sun, after which they are stored and used as required. Hand labor is generally employed, though numberless attempts have been made to facilitate the process by the introduction of various kinds of machinery. The great difficulty in the economic employment of mechanical processes is the tenacity with which the peat retains the degree of moisture remaining after it has yielded all that naturally evaporates in the air. Pressure and artificial heat have been resorted to in order to overcome this difficulty, but while the end aimed at is capable of achievement, it has usually been attained at too great an expense for economic results. A process which would put us in possession of a good and cheap peat fuel would be a national benefit to Ontario, destitute as the Province is of workable beds of coal.

Suitability of the moss for litter.

It is these absorptive properties of the sphagnum moss which have led to its employment as litter or bedding for cattle, in lieu of straw or other materials commonly used for such purposes. Its suitability for litter was doubtless recognized at an early date by people living in the vicinity of bogs, but it was as late as 1880 that the preparation of moss litter as an article of

commerce was first begun by Hollman at Gifhorn in Hanover. Since that time it has come rapidly into use in the countries of continental Europe and in Great Britain, as well as to some extent in America. The advantages claimed for the litter are that it affords drier and healthier bedding for horses and cattle than any other material; that by reason of its great power of absorbing moisture it binds the valuable portion of the animal excrements and consequently yields the best manure; that it acts as a disinfectant and improves the air of the stable, and that a smaller quantity of it is required than would be needed if straw were used. Experience with the litter in European countries seems to show that the claims made for it are well founded, and that it is the best article for the purpose yet introduced.

Absorptive qualities of the litter, and

The cells of the sphagnum moss in the manufactured article retain much of their power of attracting and holding water, and the litter is in consequence able to take up ten or fifteen times its own weight in moisture. It has the faculty of absorbing gases as well, and hence fixes the ammonia always present to a greater or less degree in the atmosphere of buildings in which animals are confined and fed. The soft, springy, elastic moss litter forms a more comfortable bed for cattle than straw, and greatly facilitates the task of keeping the animals and stables clean, a fact which has an important bearing on the welfare of man, as in the case of milch cows whose product is used as an article of human diet.

Advantages claimed for it.

Careful trials of moss litter in army stables in Germany, where formerly straw was employed, showed its superiority in the following respects: dry beds, and dry fresh air free from ammonia; the ceiling, walls and leather trappings remained free from moisture and mould. If proper care was taken to remove those portions of the litter which became charged with moisture, to shake it up every day and fork it from one part of the stall to another, the horses found their quarters very much improved. Their skins remained clean and in activity, catarrhs of the nose and eyes, generally the result of bad air in stables, were less frequent; wounds on the legs healed more speedily; colic was almost eliminated; inflammations of the glands seldom occurred, and rotting of the frog was almost entirely prevented. In cases of contagious disease, the litter proved of great value and surpassed all other disinfectants. In other cases, too, moss litter mixed with superphosphate has had the effect of protecting cattle from foot and mouth disease, even while the infection spread to an alarming extent on neighboring farms. This property would doubtless make it valuable for use in railway cars employed in the transportation of live stock. Many cases have been known in which disease was introduced or spread by cars in which infected animals had been carried.

Its manurial value.

The manurial value of moss litter after it has served its purpose in the stable is greater than that of straw, for the reason that there is less evaporation of the liquid and volatile constituents. It would appear that no

greater proportion of the potash, lime or phosphoric acid is recoverable by means of the litter, but the easily soluble nitrates are retained to a much larger extent than in the straw, which allows of their escape in the form of ammonia. As the agriculturist well knows, the nitrogen thus rendered available for plant food is a most valuable element of manure.

Sanitary and other values.

In the manufacture of moss litter as carried on in Europe a fine dust is sifted out at a certain stage of the process which, as well as the litter itself, is used as a deodorizer and absorbent of sewage and fecal matter, especially in small cities where no proper systems of sewerage or drainage exist. Accumulation of noxious matter of this sort often gives rise to epidemic and infectious diseases. The use of moss litter and peat dust not only remedies this evil, but actually transforms deleterious waste into valuable fertilizers. The absorbent properties of the litter check the growth of bacteria, and retard the decomposition of organic substances. Fresh fish, fruit and vegetables are all said to have been preserved in excellent condition for a long time by being packed in peat moss. There are many other uses to which moss litter is put, such as raw material for coarse textile fabrics, a non-conductor of heat or noise in house building, paper pulp, etc., with greater or less success.

MANUFACTURE OF LITTER IN ONTARIO.

Utilization of peat in the production of

The peat bogs of Canada, and of Ontario in particular, are of vast extent. By virtue of their immense stores of carbon they constitute a potential source of fuel supply when the right process of manufacture shall have been invented and applied. Meantime, a beginning has been made in the utilization of these bogs in the manufacture of moss litter. In the Townships of Wainfleet and Humberstone in the County of Welland, between the feeder of the Welland canal and Lake Erie, and about five miles from the town of Welland, lies a peat bog of some 5,000 acres owned by the Canadian Peat Fuel Company of Toronto. At the northern edge of this bog the Company has erected a plant for the manufacture of the litter according to a process which in some respects differs from that prevailing in Europe The upper layer of the bog consists of undecomposed sphagnum moss varying in depth from 18 inches to 4½ feet, is said to be free from sand or inorganic material, and to be well fitted for litter. The works have been erected and put in operation and a considerable quantity of product turned out. The first stage of the process is to cut the moss into pieces about 18 inches square, which are piled together in rows on the surface of the bog. When the moisture has sufficiently evaporated these blocks are gathered and wheeled in small cars over a portable tramway to the storing sheds. They are then passed through the picking machines, two of which stand side by side. These are provided with heavy revolving cylinders armed with strong teeth which act upon similar teeth set in the concave surface of a breast against which they work. In the pickers the moss is torn and loosened apart, the object being to separate the fibres rather than break them. The pickers discharge the moss upon moving carriers,

Works of the Canadian Peat Fuel Company.

three in number to each machine, ranged above one another, which carry it horizontally through a drying chamber or tunnel 116 feet in length, 8 feet high and 16 feet wide. These carriers travel against a current of hot air drawn through the tunnel by a disc fan revolving at the farther end, the object being to remove the greater part of the moisture remaining in the moss. The heat for this purpose is generated by a furnace situated parallel to the tunnel, whence the hot air is drawn by the suction of the fan into a mixing chamber, where the temperature can be regulated by the admission of cold air. The hot blast after passing over the moss emerges laden with moisture into a wooden shaft and so into the outer air. At the end of the drying tunnel the moss falls into a conveyer, from which it is elevated into a weighing bin or hopper situated above a baling press or packer. The hopper works automatically, and as soon as a sufficient weight is received it deposits its load in the press, which is a machine of peculiar design worked by steam power. On a revolving circular platform are four stout wooden moulds. In one of these wooden slats are placed to assist in securing the bale after it is pressed; it passes under the press, the workman above moves a lever and a plunger descends with a pressure of 200 tons, forcing the moss firmly into the mould. The platform makes a quarter revolution, and while the second mould is being filled, number one is being secured with wire, and at the third turn the finished bale is removed ready for shipment. The weight of a bale is 250 or 260 pounds. A knuckle-joint press is subsidiary to the steam press, but is seldom required. The bales are stored in sheds, whence they can be shipped as called for over the Michigan Central Railway, a spur of which runs into the property.

Markets for the product.

In the finished state the litter contains about 30 or 33 per cent. of moisture, and in this condition it goes into use. It is said to take up liquids more readily in this condition than when the cells of the plants are completely deprived of water, and it is not so easily broken up under the feet of horses. The output of the factory is about 40 tons per day of ten hours, but can easily be increased. The consumption in America is about 18,000 tons a year at the present time, and the article has hitherto been imported exclusively from Europe. New York, Brooklyn, Boston, Baltimore, Philadelphia, Chicago and other large cities are the chief places of use in the United States, but the market for litter is rapidly growing. It is employed in the stables of milk and transportation companies, liverymen, and other large owners of cattle and horses, and even in the stables of many private individuals. The Canadian Peat Fuel Company has entered into a contract for supplying an average quantity of 22,000 tons per year for five years in the United States. They do not anticipate any trouble in marketing this quantity. One difficulty in the way of a more general use has been the cost of storing cargoes at the point of importation. Moss litter is a bulky article, and the rates charged for storage in large cities are high. These will be avoided in the case of the Welland factory, as the litter can be kept on hand there and shipped only as required

to consumers. The price at which it retails in New York is $15 per ton. In London, England, it sells at 35 shillings per ton. The factory at Welland is the only one of the kind in America. The machinery used in it is from the designs of Mr. A. A. Dickson, the president of the company, and is patented in Canada, the United States, Great Britain, Germany and other countries of continental Europe.

Conversion of peat into fuel.

Beneath the layer of moss suitable for litter on the Welland bog lies a very large quantity of dark, decomposed peat, which it is the intention of the company to manufacture into fuel. The depth of this peaty section varies from a foot or two at the edge of the bog to 20 feet in the centre. The process of converting the crude peat into fuel is also one patented by Mr. Dickson, and as now perfected does away with artificial heat. The peat is cut and air-dried, after which it is pulverized by being passed through a picker, and automatically deposited in a hopper which feeds a steel tube about two inches in diameter and fifteen inches long. The pulverized peat is forced through this tube by pressure and formed into cylindrical blocks about three inches in length, and almost equal in density to anthracite coal. This part of the business has not yet been brought into operation.

Prospects of the industry.

Below the bed of peat lies a deposit of clay, which experiments have shown to be of fine quality for the manufacture of vitrified brick, pottery, etc. The prospect is that a very large business will be done by the company in the manufacture of moss litter, and perhaps eventually also in peat fuel. In the utilization of such dormant resources this company by its operations is really adding to the wealth of the community, and whether it can command success or not, it certainly deserves it.

LITTER AS A DEODORIZER AND FERTILIZER.

Moss litter as a deodorizer and absorbent.

In Bulletin No. 49, issued in July, 1897, by the Laboratory of the Inland Revenue Department, Ottawa, entitled "Fertilizers as Sold," Mr. Thomas Macfarlane, Chief Analyst, discusses the value of moss litter as an absorbent and deodorizer of sewage and also as a manure. He gives the following results of tests made in the Laboratory as showing the percentage of moisture, ash and nitrogen in samples of moss litter from various localities in Ontario:

Localities of samples.	Moisture.	Ash.	Nitrogen.
Light colored moss from Caledonia Springs	10.00	1.60	2.95
Dark colored moss from same locality	11.60	2.70	2.23
Peat from the same locality	10.95	3.90	2.94
Surface moss from the Mer Bleu at Eastman's	10.85	2.80	0.71
Moss litter from bog in Welland county	3.85	4.70	1.51
Peat lying underneath the foregoing	5.30	4.85	1.41

Mr. Macfarlane continues: "The first public mention of the usefulness of moss litter as a deodorizer and absorbent seems to have been made by Dr.

Ludwig Happe, in Braunschweig, in December, 1880, since which time its application for the purpose has gradually increased until now, when the system has been introduced into several towns in Germany, and is also practised in Congleton, Cheshire, England.[1] It of course at once recalls the dry earth system, regarding which great expectations were at one time entertained. The advantages of moss litter over dry earth for the purposes in question are however very decided. They consist in the perfect inoffensiveness of the moss litter product, in the fact that one part of moss litter will deodorize and dry at least six parts of mixed excreta, and in the greater agricultural value of the resulting manure. Dry earth (which is required in quantity at least equal to that of the excreta) is valueless from an agricultural point of view, but this is not the case with moss litter, which, as the above analyses show, often contains as much nitrogen as ordinary barnyard manure. Numerous analyses have been made of moss litter manure as produced in Germany, and its average contents from seven different towns may here be stated.

Value as a fertilizer.

	Per cent.	lb. per ton.	Value per ton.
Nitrogen	0.664	13.28 @ 13c.	$1 72
Phosphoric acid	0.350	7.00 @ 5c.	0.35
Potash	0.285	5.70 @ 5¼c.	0.30
Water	83.000	....	....
			$2.37

Numerous trials have been made on various crops with this manure, and very satisfactory results are always reported. In all cases it is stated to excel barnyard manure even when the latter is used in much greater quantity.

"The manufacture of moss litter has been attempted at Musquash, in New Brunswick, and it is now being produced in Welland county, Ontario. From the latter locality I was supplied with several bales of the moss litter for experimental purposes, and Dr. Laberge of Montreal undertook to superintend the carrying out of an experiment to determine its deodorizing and absorbent qualities. He reports that 100 lb. of moss litter were sufficient for drying 800 lb. of ordinary excreta from privy pits in Montreal, and rendering it entirely inoffensive. A sample of the product remained for days in my office without attracting notice, and indeed it was quite devoid of odor. Its analysis gave the following results :

Practical tests of Welland moss as an absorbent.

	Per cent.	lb. per ton.	Value per ton.
Nitrogen	1.31	26.2 @ 13c.	$3.41
Phosphoric acid	0.90	18.0 @ 5c.	0.90
Potash	0.14	2.8 @ 5¼c.	0.15
Water	65.47	....	....
			$4.46

"The valuation of ordinary fresh barnyard manure with 75 per cent. of water is about $2 per ton ; with 67 per cent. water, as in the case of the average given above by Dr. Gossman, the value is nearly $2.25. Therefore much better results might be expected agriculturally from a moss manure of the composition just described.

"Moss litter might also be applied with great advantage in public urinals. When a sample of it was supersaturated with urine and dried, and

[1] In Canada this method of deodorizing human refuse has been in use for several years at Caledonia Springs.

this process repeated several times, no offensive odors were developed, and the product was found on analysis to contain 12.41 per cent. of nitrogen, which is equal to a valuation of $32.26 per ton.

A practical suggestion.

"These facts are reported in order to show that Canada possesses in her waste lands abundance of material which might be used in our towns and villages for the production of a very valuable manure, with the simultaneous introduction of very many sanitary advantages. It is not to be expected that cities or towns which are advantageously situated for the water carriage system or which have already adopted it will make any changes, but there are many towns and villages in the Dominion where the application of the moss litter system would be very suitable, and the authorities of which, by selling the product or giving it gratis to the farmers of the neighborhood, might confer a great advantage on agriculture."

T. W. G

Welland peat bog. General view of works.

Welland peat bog. Longitudinal view of rows of cut peat.

Welland peat bog. Transverse view of rows of cut peat; portable tramway on the right.

Welland peat bog. Picking machines for loosening fibre of crude moss.

SECTION VII.

MINING SCHOOLS IN ONTARIO.

There are two schools in Ontario where instruction is given in subjects intimately related to the theory and practice of Mining. One of these is the School of Practical Science in Toronto, and the other is the School of Mining at Kingston. Both schools receive liberal aid from the Provincial Government, and within the last three years important additions have been made to the staffs of both, as well as to their mechanical equipment. Provision is made in both for a full course in mining engineering, and also for special courses which aim at giving practical instruction to prospectors. The attendance of students is steadily growing, and owing to the demand for the service of mining engineers the number who are taking the full course is much larger than at any former period in the history of the institutions.

Mining Schools of the Province.

SCHOOL OF PRACTICAL SCIENCE, TORONTO.

During the past year the School of Practical Science has been attended by 135 students in all the engineering departments, and 40 in the prospecting class. Of this number 76 belonged to the Mining Department. The staff of the School of Science consists of a principal, two professors, five lecturers and six demonstrators and fellows. Of these, one professor, one lecturer and one demonstrator belong to the Mining Department.

Attendance of students.

The equipment of the School in the Mining Department includes the following museums and laboratories:

Equipment of the Mining Department.

During the past session thirty cases have been added to the Geological Museum, which includes a collection of minerals, rocks and fossils. There is a large general collection of minerals classified in the usual manner, and intended for comparison and reference in advanced classes; but special attention is paid to the extensive collection of Ontario minerals, which, with few exceptions, contains all the species known in the Province, and is particularly rich in examples of economic minerals. The Ontario collection is constantly being added to, and is believed to be as complete as any in the Dominion.

Museums.

Adjoining the mineral collection is a series of ores of all descriptions, particular attention being given to the gold and silver ores of Canada, care being taken to secure typical examples, especially of Ontario gold ores.

The rocks also are arranged in two collections, one a large general collection from foreign localities, containing massive schistose and sedimentary rocks; the other a set of Canadian rocks, specially complete in typical country rocks from important ore deposits. An extensive set of thin sections enables advanced students to study both rock collections microscopically.

The palæontological collection consists of fossils and casts, including the chief typical forms needed for determining the age of sedimentary rocks.

A number of wall cases have been prepared for a collection of specimens illustrating industrial chemistry, and a beginning made towards arranging the materials on hand.

In a separate room there is an interesting collection of dressed building and ornamental stones from various parts of Ontario, serving as illustrations in the Architectural Department.

The Chemical laboratories.

The qualitative laboratory affords accommodation for about forty students working at one time. The working tables are supplied with water and gas, and there is a fume cupboard within easy reach of each. A complete set of apparatus is supplied to each student on payment of the deposit prescribed.

The quantitative laboratories will accommodate about twenty students. They are furnished with convenient work tables and fume cupboards, and are supplied with the most recent apparatus for gravimetric, volumetric and gasometric analysis, both scientific and technical.

The apparatus includes a number of excellent balances by the best makers, furnaces for fusion, etc., and for organic combustions, for experimental vacuum, pan and filler press; a very complete set of apparatus for technical gas analysis; all requisites for the assay of ores and furnace products in the wet way; the latest forms of Fischer's and Mahler's apparatus for the determination of the heating power of fuel; facilities for the electrolytic determination of metals, including a Gulcher's thermo-electric pile, spectroscopes, polariscopes, microscopes, and, in short, all the apparatus required for a thorough course in analytical chemistry and assaying.

Blowpipe laboratory.

The blowpipe laboratory has Bunsen burners and all necessary accomodation for thirty-six students working at once. All the chemicals and reagents necessary for both qualitative and quantitative blowpipe work are kept here; also a stock of minerals sufficient for a complete course in qualitative blowpipe work, and a number of silver ores in which the silver has been carefully determined for quantitative blowpipe assay. In the balance room adjoining the blowpipe laboratory there is a Jolly balance for determining the specific gravity of minerals.

Assaying laboratory.

The assaying laboratory is equipped with three gas crucible furnaces, three gas muffle furnaces, two gas roasting furnaces, three charcoal crucible furnaces and one charcoal cupel furnace, a Taylor hand crusher, Blake laboratory crusher, a muller and all other necessary appliances for pulverizing and preparing ores for fire assay. Adjoining the assay laboratory is a room with a lathe for preparing rock sections for examination under the microscope; also the necessary appliances for making rock sections by hand. Four petrographical microscopes are reserved for the use of advanced students in lithology.

Mill room.

The mill room contains a Dodge crusher, a Tulloch ore feeder, a Fraser and Chalmers three-stamp mill, with amalgamated silvered copper plates, and a Frue vanner. The concrete floor of the mill room provides ample space for sampling lots of ore of one or two tons. The machinery is driven by an eight h.p. Edison motor, which is supplied with current from the city circuit. The mill room is also provided with settling tanks for the tailings and concentrates.

With this plant a complete mill test can be made of a ton or more of ordinary mill ore, thus affording an opportunity to those desiring it of having a test made under conditions similar to those of actual practice, and upon a larger scale than that of an assay of a few pounds.

The mill room affords the student an excellent opportunity of studying milling, as all the machines in use are of the same construction as those employed in the best large mills.

During the coming summer two other rooms will be fitted up in which will be erected a reverberatory furnace for roasting sulphide and arsenical ores, leaching vats for treating ores by the cyanide process, and a chlorination plant. This will complete the equipment for treating gold ores, and will make it possible to extract the gold from the concentrates saved by the Frue vanner. The furnace will enable students to study the reactions which occur in the roasting of the different ores.

The mill was completed and in running order in February, 1896. A number of trial runs were made during March on samples of a few hundred pounds each for the purpose of getting the mill in good working order. The first test made on 1,054 pounds ore showed it to contain a small amount of free gold, as well as some value in concentrates. Second, 1,050 pounds, small value as free gold and also in concentrates. Third, 526 pounds, small value in free gold, no concentrates. Fourth, 1,500 pounds, gave only trifling value in free gold, concentrates had no value. Fifth, 850 pounds, gave mere trace. Sixth, 1,200 pounds, medium grade ore, value both as free gold and concentrates. In addition to these, several tests were made by various classes of students who conducted the operations themselves under supervision. Records of mill tests.

Two of the above samples were from the Sudbury district and the others from northwestern Ontario, but as the shippers in nearly every case wished the results to be confidential no particulars can be given as to the exact locality or name of shipper.

SCHOOL OF MINING, KINGSTON.

The School of Mining is a branch of the School of Mining and Agriculture, incorporated by Act of the Legislature of Ontario. It is supported by a grant from the Ontario Government and by subscriptions from citizens of Kingston, Toronto, Deseronto, Ottawa, Peterborough, Norwood, Belleville, Cornwall, Renfrew, Gananoque, Buckingham, Brockville, Almonte, Arnprior, Pembroke, Lancaster, Braeside, Smith's Falls, Lanark, Perth and Hamilton. Incorporation and support.

The objects of the School are to give a thorough scientific education, both theoretical and practical, to men studying for the professions of mining engineer, assayer, consulting geologist and metallurgist; and to provide for prospectors, mine foremen and others interested in the discovery and winning of minerals such instruction as shall make their occupations more interesting and less liable to failure. Objects of the School.

Relation to Queen's University.

The School has been placed near Queen's University so as to take advantage of the instruction therein provided in English, mathematics, physics and the biological sciences. It is in this way possible to equip and carry on a good technical school on a much smaller revenue than would otherwise be called for to maintain the high standard of scholarship which the age demands of the engineering profession.

Advantages of location.

Kingston is peculiarly well situated as the seat of a mining school. Geology and mineralogy, two of the fundamental subjects of a mining engineer's education, are studied to best advantage where the minerals can be seen as they lie in nature, and where geological formations can be examined *in situ*. In a few hours a class of students can be taken by carriage to a region so rich in mineral species that about forty different kinds have been secured in an afternoon. There is also a great variety of geological formations close at hand. If to this be added the neighborhood of mines in process of development or in operation, the result is an ideal mining school city. The German Government has planted its mining schools in just such cities, where the education of the mining engineer can be given that practical turn which not only lends a charm to the period of his study, but shortens the time between graduation and thorough efficiency and confidence in the practice of his profession.

The possibilities of the country to the north are, in these respects, very great, and a glance at a geological map shows that Kingston itself is situated where the mineral-bearing formations, cutting like a broad wedge through the limestone, reach the St. Lawrence and lake Ontario. The region of mineral-bearing rocks is thus brought almost to the gates of the city. On either side the water front is bordered by a band of limestone, broadening as it extends east and west.

The School of Mining is open to all who wish by earnest study to enlarge their knowledge of minerals and mines, or to pursue science for its own sake. The atmosphere of the school is suitable only for those who are fond of steady work.

Entrance of students.

While students are admitted to a course for a diploma (three years) or a degree (four years) upon matriculating in English and mathematics, it is strongly urged upon them to take the complete matriculation examination with the modern language and science option. As a good grounding in mathematics is necessary, it will be found advantageous to have attained the senior leaving standard in that subject before entering.

Equipment of the School.

The school is now provided with a mining laboratory and experimental reduction works, which is furnished with a stamp mill, a concentrator, a sample grinder, rolls and other machines with which ores are treated at the mines; also a reverberatory roasting furnace, a chlorination plant and a cyanide plant. In selecting these machines, local and provincial as well as general conditions have been kept in view. The machines are of sufficient size to operate upon large quantities of ore (a ton or two can be easily handled). To test the suitability of processes, by getting such tests made, costly mistakes may be avoided. The value of the mill in this respect has already been shown in several instances.

The mining laboratory is a distinctive feature of well-equipped mining schools. The various operations of crushing, stamping, grinding, amalgamating, concentrating, chlorinating, sampling and assaying are by its aid studied in such a way as to give the student a lively appreciation of the difficulties to be overcome and the care necessary in these operations.

Through the kindness of the Ingersoll Drill Company, Montreal, there has been added to the collection of machinery for demonstration an Ingersoll rock drill, complete, which can be attached by hose to the laboratory steam and shown in operation. The Northey Manufacturing Company, Toronto, has also presented the School with a mining pump with all attachments complete.

During its short history the Kingston School of Mining has made considerable contributions to the advancement of mining education and interests in Ontario. Its success seems to be due to the fact that the members of its staff, while not losing sight of the value of sound scholarship, also appreciate the importance of practical training.

SUMMER MINING SCHOOLS.

Prospectors' classes, or Summer Mining Schools, were carried on under the direction of the Kingston School of Mining at a number of places in the mining districts of eastern and northwestern Ontario during the season of 1896. Those in the eastern part of the Province were held at Eganville and Renfrew in the county of Renfrew, and at McDonald's Corners in the county of Lanark. The classes were conducted by Prof. W. G. Miller of the School of Mining, who was assisted at Eganville and Renfrew by Mr. R. O. Hiscock, M.A. It had been decided to hold classes only in places from which applications for such instruction had been received, and where there seemed likelihood of the work being prosecuted with success. The places named were the first to apply, and they were consequently given priority over applications which were subsequently received from other places. At Eganville and Renfrew instruction was given during the mornings, afternoons and evenings, consisting of teaching in elementary mineralogy, geology and methods of prospecting, together with a few demonstrations on the assaying of gold and silver ores. The lectures were illustrated by a collection of rocks and minerals, maps and diagrams, and the outfit further consisted of a portable assay furnace together with blowpipes, chemical reagents and a few text books. The instruction was made as practical as possible, individuals being dealt with as such rather than in classes; and in addition to the general course special subjects were treated in which members of the class were more particularly interested. Several properties in the neighborhood were visited and advice given as to their value and the best methods of working them. Free assays were also made on all samples brought in which appeared worthy of such labor, and many specimens of mineral were identified. The attendance at Eganville was twenty-five and at Renfrew fifty. At McDonald's Corners it was not found advisable to hold classes during the day, as most of the men lived at some distance from the village and were engaged up to six o'clock. The classes opened at 7 p.m., and as the June evenings were long there was con-

siderable time for examining specimens and conducting experiments. A large number of prospects were examined in this vicinity, and a great variety of specimens reported on for members of the class. The attendance was twenty-five. At all places in which classes were held the work was well received, and every assistance in their power was given by the civic officials and the local press. The results achieved by holding these classes may be summarized as follows: (1) Knowledge of minerals and rocks was imparted. (2) Mineral specimens of local or general interest were examined and identified. (3) Free assays of ore were made. (4) Interest in the mineral resources of the respective neighborhoods was aroused and stimulated.

Classes at Mine Centre, Rat Portage, Port Arthur and Sault Ste. Marie were conducted by Mr. W. Hamilton Merritt, the total attendance numbering about 200. The work of the classes was on the same general plan as that described above, and Mr. Merritt reports that considerable interest was aroused, and that in his opinion the classes were productive of much good.

During the month of September the annual course in prospecting and field geology in connection with the Kingston School of Mining was given under the direction of Prof. W. G. Miller. The party met at the O'Connor House, Marmora station, on September 1st. Three days were spent at this place in visiting the gold mines in the vicinity and collecting samples of minerals and ores. Canoes and outfit were then portaged into Crow Lake, and visits made to the lithographic works and the Blairton iron mines which are situated on its shores. The course of the party then lay via the Crow and Deer rivers to Coe Hill. Numerous "prospects" were examined along these rivers and specimens collected. Two days were spent visiting the mineral properties in the immediate vicinity of Coe Hill. From this point the party portaged into the York branch of the Madawaska river. In the township of Dungannon near the village of Bancroft an examination was made of the remarkable mass of rocks discovered and described two or three years ago by Prof. F. D. Adams of McGill University. This rock is known as nepheline syenite and has not been found in any other part of Ontario. From this area numerous samples of the rare minerals nepheline and sodalite were obtained, besides specimens of many other more common minerals. The geological features of the country along the York branch to the Madawaska river were examined, and Palmer's Rapids P.O. was reached on September 21st. The Madawaska was ascended to Barry's Bay station of the Ottawa, Arnprior and Parry Sound Railway, where the train was taken for Renfrew. During the trip the members of the party were enabled to collect many specimens suitable for exhibition in the School museum, and also material which will be of great service in making up the collections designed for the use of prospectors. It would be difficult to find a tract of country of the same size which shows a greater variety of minerals, economic and otherwise, than this part of North Hastings through which the route lay. Several short field excursions were made with students of the school during the months of October and November. On one of these excursions a steam yacht was chartered, and three days were spent collecting specimens and studying the geology of the district along the Rideau Canal.

SECTION VIII.

MINERAL COLLECTIONS FOR SUMMER MINING SCHOOLS.

The students who have attended the Summer Classes of Mining Schools conducted during the past three years at the several mining centres of the Province, under the auspices of the Government, have warmly appreciated the work done by their instructors; and there is no doubt that the plan has been instrumental in preparing for the field a distinctively improved body of prospectors. But obviously the work of instruction by means of lectures may be assisted by providing a suitable equipment, and among the students themselves the want most generally voiced has been for a typical collection of minerals. Numerously signed petitions were sent in to the Commissioner of Crown Lands last year praying that such collections might be supplied, and in compliance therewith a grant of money was obtained from the Legislature for this object. The task of preparing cabinets was entrusted to the Professors of the Kingston School of Mining, and as a result collections of minerals and rocks have been installed at Rat Portage, Port Arthur, Sault Ste. Marie, Sudbury and Marmora. Each collection consists of 226 specimens, representing 224 species and varieties of rocks and minerals. These specimens are classified according to the valuable constituent, so far as this mode of classification could be applied, and each one is numbered and labelled. The collections are displayed in sloping cases, with dust proof glass tops, and with each one thus described is a second collection representing the more important rocks and minerals placed in locked drawers and intended for handling by the instructors and students during class hours. A descriptive catalogue has been prepared by Dr. Goodwin and Mr. Miller which is printed below, and as a liberal number of copies of this Report will be presented to the trustees of each school opportunity will be found for careful study of the specimens by every one who is interested in improving his knowledge in this important field of natural history. The following Rules have been prepared and adopted for the care and use of collections:

Equipment of Summer Mining Schools.

Preparation of cabinets of minerals.

REGULATIONS UNDER WHICH THE COLLECTIONS OF MINERALS AND ROCKS MADE BY THE BUREAU OF MINES SHALL BE HELD AND USED.

1. The collection shall be in the care of two trustees, one appointed by the Commissioner of Crown Lands, and the other by the Municipal Council or other public body selected by the Commissioner for that purpose.

2. The Municipal Council or other body shall provide a suitable place for the collection, easily accessible to prospectors and others who wish to examine specimens in it.

3. The specimens under glass are not to be removed except in the presence of a trustee, or of an instructor of a mining class, and are to be returned to their places without delay. On no account are they to be cut, or scratched, or taken from the room in which the collection is placed.

4. The specimens in the drawers may be put into the hands of students or of others wishing to use them for study or comparison; but on no account are they to be taken away permanently.

5. The copies of these Regulations and of the Descriptive Catalogue deposited in the collection are to be used for consultation by the mining classes, and others making use of the collection ; but they are not to be taken away for private use.

6. The keys of the collection are to be kept, one set by each of the trustees, but the trustees are required to provide the instructor of a mining class held in the municipality with a set of keys so long as he requires them. The instructor must return the keys immediately upon closing the class for the season or year ; and must, if called upon to do so, satisfy the trustees that the collection has not been injured or impaired while being used by him.

7. The collection may be used for any educational purposes at the discretion of the trustees, provided always that such use does not in any way injure or impair it, and provided that such use does not interfere with the main objects for which the collection is intended, viz., for the instruction of classes in mining, and for the use of prospectors.

8. If the Commissioner is satisfied that the collection has ceased to answer the purposes for which it was intended, he may cause it to be removed.

The Commissioner of Crown Lands has appointed the following persons as trustees of the collections in the several towns and villages in which for the present they have been placed, viz. : William Margach at Rat Portage, Sheriff Thomson at Port Arthur, R. A. Lyon at Sault Ste. Marie, T. J. Ryan at Sudbury and A. W. Carscallen, M.P., at Marmora.

It is desirable that the collection in each place should be enlarged by the addition of local rocks and minerals, and the cabinet collection will make the naming of specimens comparatively easy.

PART I. MINERALS.

By W. G. Miller.

Definition of minerals.

A mineral may be defined as being any natural substance occurring apart from the bodies of plants or animals and having theoretically a definite chemical composition. Most minerals show a tendency to assume definite forms, bounded by planes. These forms are called crystals.

Crystals although exceedingly numerous have been referred to six systems, known as I, Regular, Cubical or Isometric ; II, Tetragonal ; III, Orthorhombic or Rhombic ; IV, Hexagonal ; V, Monoclinic ; and VI, Triclinic.

Minerals are determined and identified by means of their chemical, crystallographic and other characters, such as hardness, specific gravity, color, lustre and fracture. Sometimes it is necessary to make thin sections or slices of them and examine them microscopically.

For the determination of the chemical characters of minerals the mouth blowpipe is a very serviceable instrument. A set of blowpipe apparatus containing all the instruments necessary for ordinary tests can be obtained for two or three dollars. Paraffin, the substance of which ordinary wax candles are composed, makes a suitable fuel for the blowpipe lamp. Full directions for performing blowpipe operations are given in Chapman's Blowpipe Practice (Copp-Clark Co., Toronto, price $2.50).

Formulas of minerals.

Formulas are a short way of showing at the same time the elements forming a mineral, and the proportions by weight of each element in the mineral. A capital letter, or a capital letter with a small one attached, usually the first letter or letters of its name in Latin or English, stands for a particular number of parts of each element. Thus, PbS stands for the mineral

galena, made up of lead 207 parts (Pb), and sulphur 32 parts (S). In most formulas one or more of the letters may have a number attached. This number multiplies the parts for which the letter stands. For example, Ag_2S stands for argentite, composed of silver, twice 108 parts, and sulphur 32 parts. From the formulas it is easy to calculate the per cent. of any element in the mineral. For example, in argentite, Ag_2S, there are twice 108 or 216 parts of silver to 32 of sulphur. That is 216 parts of silver to 248 of argentite. How much silver in 100 of argentite? $216 \times \frac{100}{248} = 87 +$, that is 87 per cent. of silver.

Elements.	Symbols.	Proportionate Parts.
Aluminium	Al	27
Antimony	Sb	120
Arsenic	As	75
Bismuth	Bi	209
Bromine	Br	80
Chlorine	Cl	35.5
Chromium	Cr	52
Cobalt	Co	59
Copper	Cu	63.5
Fluorine	F	19
Gold	Au	197
Hydrogen	H	1
Iodine	I	127
Iron	Fe	56
Lead	Pb	207
Manganese	Mn	55
Mercury	Hg	200
Nickel	Ni	59
Oxygen	O	16
Silicon	Si	28.5
Silver	Ag	108
Sulphur	S	32
Tin	Sn	118
Zinc	Zn	65

Scale of hardness.

A scale of hardness was prepared by Möhs many years ago. In this scale ten degrees of hardness are made use of as follows:

1. Talc. 2. Gypsum. 3. Calcite. 4. Fluorspar. 5. Apatite. 6. Felspar. 7. Quartz. 8. Topaz. 9. Corundum. 10. Diamond. If a mineral scratches and is scratched by calcite, its hardness is said to be 3. If it is softer than fluorspar, but scratches calcite, its hardness is said to lie between 3 and 4. A mineral having a hardness of 2 or less can be scratched by the finger nail. Minerals over 5 in hardness can be scratched with difficulty, if at all, by a knife.

Table of hardness and specific gravity of minerals.

The following list gives the hardness and specific gravity of a number of the most common minerals with others referred to in this catalogue:

Minerals.	Hardness.	Specific gravity.
Molybdenite	1—1.5	4.7—4.8
Cerargyrite	1—1.5	5.5
Graphite	1—2	2 —2.2
Sulphur	1.5—2.5	2
Realgar	1.5—2	3.5
Orpiment	1.5—2	3.4—3.5
Wad	1 —6	3 —3.2
Bauxite	1 —6	2.5
Garnierite	1	2.3—2.8
Bismite	1	4.3
Erythrite	1.5—2.5	3
Gypsum	1.5—2	2.3
Stibnite	2	4.5—4.6
Halite	2.1—2.2	2.5
Argentite	2 - 2.5	7.2—7.3
Stephanite	2 —2.5	6.2—6.3
Bismuth—native	2 —2.5	9.7—9.8

Minerals.	Hardness.	Specific gravity.
Cinnabar	2 —2.5	8 —8.2
Pyrolusite	2 —2.5	4.7
Kaolin	2 —2.5	2.6
Jamesonite	2 —3	5.5—6
Bismuthinite	2	6.4—6.5
Pyrargyrite	2.5	5.7—5.8
Galena	2.5—2.7	7.4—7.6
Meneghinite	2.5	6.3—6.9
Cryolite	2.5	3
Chalcocite	2.5—3	5.5—5.8
Bournonite	2.5—3	5.7—5.9
Chrysocolla	2.4	2.2—2.3
Copper—native	2.5—3	8.9
Gold—native	2.5—3	15.6-19.6
Silver—native	2.5—3	10.1-11
Barite	2.5—3.5	4.3—4.6
Serpentine	2.5—5.5	2.2—2.6
Golden Mica	2.5—3	2.7—2.8
Wulfenite	2.7—5.3	6.7—7
Anglesite	2.7—5.3	6.12-6.39
Bornite	3	4.9—5.4
Calcite	3	2.7
Anhydrite	3.3—5	2.9—2.98
Celestite	3.3—5	3.96
Cerussite	3 —3.5	6.4—6.5
Tetrahedrite	3 —4.5	4.4—5
Millerite	3 —3.5	5.3—5.65
Chalcopyrite	3 —5.4	4.2
Cuprite	3.5—4	5.85—6.1
Chalcotrichite	3.5—4	5.85—6.1
Malachite	3.5—4	4
Azurite	3.5—4	3.7—3.8
Siderite	3.5—4	3.8
Arsenic—native	3.5	5.6—5.7
Alunite	3.5	2.5—2.7
Sphalerite	3.5—4	3.9—4.1
Pyrrhotite	2.5—4.5	4.58-4.64
Rhodochrosite	3.5—4.5	3.4—3.6
Fluorite	4	3 —3.2
Platinum—native	4 —4.5	14 —22
Zincite	4 —4.5	5.4—5.7
Stannite	4	4.3—4.5
Apatite	4.5—5	3.1—3.2
Scheelite	4.5—5	5.9—6.1
Calamine	4 —5.5	3.4—3.5
Monazite	5 —5.5	4.9—5.3
Sphene	5 —5.5	3.4—3.5
Smithsonite	5	4.3—4.85
Niccolite	5 —5.5	7.3—7.6
Ilmenite	5 —6	4.5—5
Limonite	5 —5.5	3.6—4
Wolframite	5 —5.5	7.2—7.5
Amphibole	5 —6	2.9—3.4
Actinolite	5 —6	3—3.2
Tremolite	5 —6	2.9—3.1
Asbestos	5 —6	3
Pyroxene	5 —6	3.3—3.6
Labradorite	5 —7	2.7
Scapolite	5 —6	2.6—2.7
Chromite	5 —5	4.3—4.5
Linnæite	5 —5	4.8—5
Cobaltite	5 —5	6 —6.3
Gersdorffite	5 —5	5.5—6.2
Magnetite	5.5—6.5	5.17
Hæmatite	5.5—6.5	4.9—5.3
Smaltite	5.5—6	6.4—6.6
Chloanthite	5.5—6	8.4—6.6
Turquoise	6	2.6—2.8
Orthoclase	6	2.4 -2.6
Pyrite	6 —6.5	4.9—5.1
Marcasite	6 —6.5	4.8—4.9
Microcline	6 —6 5	2.5
Albite	6 —6.5	2.6
Cassiterite	6 —7	6.8—7.1
Sperrylite	6 —6	10.6
Garnet	6.5—7.5	3.1—4.3
Quartz	7	2.6

Minerals.	Hardness.	Specific gravity.
Tourmaline	7 —7.5	2.9—3.2
Zircon	7.5	4.2—4.8
Beryl	7.5—8	2.6—2.8
Topaz	8	3.4—3.6
Ruby	9	3.9—4.1
Sapphire	9	3.9—4.1
Corundum	9	4
Diamond	10	3.5

The specific gravity of a mineral is its relative weight compared with that of water. Quartz is said to have a sp. gr. of 2.5 because a mass of it is two and one-half times heavier than an equal bulk or volume of water. Descriptive terms.

The color of a mineral is often quite variable. Thus, specimens of fluor spar may be white, greenish, pink or purple. In minerals which are metallic in appearance the color however is generally constant.

The lustre of a mineral refers to the appearance of its surface when light falls upon it. It may be metallic, glassy, earthy or otherwise.

The fracture of minerals refers to their manner of breaking. It may be even, uneven, splintery or of another character. When a crystal shows a tendency to break in certain directions more readily than in others, it is said to possess cleavage. Calcite and fluor spar possess a well-defined cleavage.

According to its tenacity a mineral is said to be brittle, sectile, malleable, flexible or elastic.

Some minerals possess a characteristic feel—soapy, etc.

The taste and odour of certain minerals assist in their identification.

DETERMINATION OF MINERALS.

In the following table the numbers refer to pages in E. S. Dana's "Minerals and and How to Study Them," where the mineral is described :

I. The Mineral has a Metallic Lustre.

a. YELLOW COLOR.

Table for determination of common minerals by field tests.

1. ONLY SLIGHTLY SCRATCHED BY KNIFE.
   - Brass yellow, often in cubes ; streak, grayish black. — IRON PYRITES, FOOLS' GOLD, OR PYRITE (213)
   - Light yellow or yellowish white ; weathers easily to rust. — MARCASITE (251)
2. EASILY SCRATCHED BY KNIFE.
   - Malleable. — GOLD (179)
   - Magnetic ; bronze yellow in color : surface often tarnished ; streak, black. — PYRRHOTITE (212)
   - Brass yellow with often a variegated tarnish. Streak, dark green or greenish black. — CHALCOPYRITE, OR COPPER PYRITES (191)

b. RED COLOR.

1. MALLEABLE. — NATIVE COPPER (189)
2. NON-MALLEABLE.
   - Perhaps slightly magnetic ; streak, red. — HEMATITE (217)
   - Always with variegated purple tarnish, but reddish on fresh fracture ; streak, grayish black. — BORNITE (190)
   - Plate copper red : hard. — NICCOLITE (227

c. GRAY COLOR.

1. SCARCELY SCRATCHED BY KNIFE.

Steel gray color, micaceous structure; streak, dull red.	SPECULAR ORE, OR HÆMATITE (217)

2. EASILY SCRATCHED WITH KNIFE.

Dark lead gray color; blue or green tarnish; streak, black.	CHALCOCITE, OR COPPER GLANCE (190)
Lead gray color; cubic cleavage.	GALENA (198)
Bluish light gray; often dark tarnish; good cleavage in places.	STIBNITE (176)
Light gray, soft, compact, granular.	FAHL ORES (193)

d. WHITE COLOR.

1. SCARCELY SCRATCHED BY KNIFE.

Silver white or pale gray; streak, grayish black; closed tube metallic mirror, then black, red and yellow sublimate.	ARSENOPYRITE (215) OR MISPICKEL.
White to pale yellow; exposed surface rusted.	MARCASITE (215)

2. EASILY SCRATCHED.

Malleable, often black tarnish and wire-like form.	SILVER (183)
Silver white; brilliant lustre; very soft; very heavy.	SYLVANITE (181)

e. BLACK COLOR.

1. SCARCELY SCRARCHED BY KNIFE.

Streak, black; magnetic.	MAGNETITE (219)
Streak, brown or blackish brown; very slightly magnetic.	TITANIFEROUS IRON (222) OR ILMENITE.
Streak, brown or greenish; very slightly magnetic.	CHROME IRON (221)

2. EASILY SCRATCHED BY KNIFE.

Mostly in scales; mark on paper; greasy feel.	GRAPHITE (168)
Black or dark lead gray; malleable.	ARGENTITE (184)

II. The Lustre of the Mineral is Sub-Metallic.

1. SCARCELY SCRATCHED BY KNIFE.

Streak, brown; color, brown or reddish.	CASSITERITE, OR TINSTONE (207)

2. SCRATCHED BY KNIFE.

Good cleavage; streak, brown; color, brown or black.	SPHALERITE, OR ZINC-BLENDE (233)
Very soft and very heavy; color, cochineal red and sometimes dark; streak, scarlet.	CINNABAR (187)

III. The Mineral has a Non-Metallic Lustre.

A.—STREAK, DISTINCTLY COLORED.

1. Streak, brown or yellowish;	
not scratched by knife.	CASSITERITE (207)
Scratched by knife; good cleavage.	SPHALERITE (233)
2. Streak, yellow or brownish yellow; botryoidal surface; or earthy?	LIMONITE OR BOG IRON (222)
3. Streak, red.	HÆMATITE (217)
4. Streak, pale green; color, green.	MALACHITE (195
5. Streak, pale blue; color blue.	AZURITE (196)

B. STREAK, WHITE OR FAINTLY COLORED.

a. NOT SCRATCHED BY KNIFE.

1. Cleavage, none, or indistinct.	
Vitreous, colorless, to amethystine and black.	QUARTZ (273)
Vitreous or stony compact.	CHALCEDONY (278)
Vitreous ; black, dark brown or green ; in triangular prisms often striated and broken.	TOURMALINE (317)
Dark red or brown ; generally in isolated rounded crystals.	GARNET (309)
2. The mineral has a distinct cleavage.	
Vitreous or pearly ; white, gray, red, green, etc. ; very perfect cleavage.	FELSPAR (284) Orthoclase and plagioclase.
Vitreous ; black, brown, green, greenish white or colorless ; crystalline or fibrous.	
Six-sided prisms.	HORNBLENDE (297)
Eight-sided prisms.	PYROXENE (292)

b. SCRATCHED BY KNIFE.

Yield no water in closed or open tube.	1. White gray, etc., soft ; remarkable rhombohedral cleavage ; effervesces in cold acid.	CALCITE (247)
	2. Same, but effervesces only in hot acid.	DOLOMITE 260)
	3. Mostly with good cleavage ; very heavy ; light colors.	HEAVY SPAR, OR BARITE (262)
	4. Same, but not quite so heavy ; often fibrous structure.	CELESTITE 26[illegible]
	5. Harder ; violet blue, green, grayish.	FLUORSPAR (245)
	6. Hard ; often in six-sided prisms ; green, reddish brown, etc.	APATITE (254)
Soft and often in thin plates or scales. Yield water in the open or closed tube.	1 Very soft ; scratched by nail ; white or grayish ; often satiny lustre.	GYPSUM (256)
	2. Sectile ; soapy feel ; green, brown, white or mottled.	TALC (326) OR SOAPSTONE.
	3. Like talc ; or fibrous.	SERPENTINE (310)
	4. Dark or [illegible] green ; earthy or scaly.	CHLORITE (310)
	In [illegible] leaves or scales ; cleaving into thin plates.	
	White or brownish.	MUSCOVITE (304)
	Brown or black.	BIOTITE (308)

A suitable text-book for beginners in mineralogy is E. S. Dana's Minerals, and How to Study Them." (John Wiley and Sons, New York, price 1.50.) In examining specimens referred to in this catalogue, it is advised hat this book be used in reading up their descriptions. *Sources of information.*

The descriptions contained in the catalogue are necessarily brief and ncomplete.

A large amount of information on Ontario minerals may be obtained from he annual reports of the Bureau of Mines, Toronto, and from the publications f the Geological Survey, Ottawa. Lists of these reports and publications can e obtained by application to the Director of the Bureau of Mines, or to the Director of the Geological Survey. The issues of the Canadian Mining Reiew, Ottawa, and other mining papers, should also be consulted. Valuable nnual publications are the Canadian Mining Manual (Mr. B. T. A. Bell, Ottawa) and the Mineral Industry, its Statistics, Technology and Trade. Scientific Publishing Co., New York.)

PART II. CATALOGUE OF MINERALS IN THE COLLECTION.

By Prof. W. L. Goodwin.

The specimens are grouped according to their valuable constituent, as Ores of Gold, Ores of Iron, etc., and the number in the title corresponds with the number of the specimen in the collection.

GOLD.

Ores of Gold.

1-2. Gold, native in quartz, etc.

Gold is often found in veins of quartz intersecting crystalline rocks, but the gold may extend more or less into the wall-rock, i.e., the rock through which quartz cuts. This wall rock frequently belongs to the class called schists; less commonly it consists of diorite, granite, porphyry or other rock. The gold is sometimes visible, but often invisible, even with aid of a magnifying glass. When not visible in the rock, it can often be seen among the heavy sand left by powdering the rock and washing away the lighter material (panning). When visible, the gold can be distinguished from other yellow minerals by the ease with which it can be cut or pressed out with the point of a knife, while pyrites and golden mica can be ground to a powder by rubbing with the knife. Unlike other materials, a speck of gold has the same appearance no matter from what direction it is viewed. The minerals most commonly found in gold quartz are iron pyrites, copper pyrites, galena, arsenopyrite, zinc-blende and pyrrhotite. These minerals form the "concentrates" when the ore is milled. The gold is often found in these minerals, or in the cavities or loose material formed by the rusting of pyrites. Pure gold, 1000 fine, is worth $20.67 an ounce Troy. Silver gives it a greenish or whitish color. Native gold may contain silver in any proportion. Copper imparts a reddish or brownish tint. Sand, gravel and other loose materials formed by the wearing down of rocks containing gold, are likely to be auriferous (gold-bearing.) Gold found in these situations is called alluvial gold, or placer gold. Gold-bearing quartz or other veins can usually be found at no great distance from the placer mines. The auriferous sands commonly contain magnetite, small garnets, zircons, topaz, corundum, platinum and other heavy minerals.

3. Gold, native in Mispickel.

Gold is found in pyrite, mispickel or arsenopyrite, galena, zinc-blende, or related minerals, sometimes visible, as in this specimen, but oftener invisible. From such ores the gold often cannot be extracted by amalgamation. Some chemical process such as chlorination or cyanidation must be used.

4. Iron Pyrites, or Fool's Gold.

Can be distinguished from gold by its hardness, brittleness and color.

PLATINUM.

Ores of Platinum.

5. Platinum, native.

Found in alluvials, often along with gold; rarely in solid rock. It usually contains as an alloy iron, copper and other metals. The percentage of platinum ranges from 50 to 85 It is sometimes magnetic, owing to the

presence of iron. The pure metal is heavier than gold, but as it occurs in nature it is somewhat lighter. It is like silver in color, but is considerably harder. It is found in small grains and nuggets. In Canada it has been found in Beauce county, Quebec, and in several parts of British Columbia. Pure platinum is at present worth from $13 to $14.50 an ounce. Its market value varies a good deal.

6. Sperrylite, or Platinum Arsenide—$PtAs_2$.

Found in small amount in the loose, decomposed material called gossan at the Vermilion mine, west of Sudbury, Ont. The mineral as obtained by washing the gossan consists of small shining crystals, tin-white in color, but brittle It contains 56½ per cent. of platinum. This is the only known occurrence of platinum in combination with another element. The specimen in the collection is in some cases concentrates from the gossan in which the sperrylite is found. The sperrylite can be seen as bright metallic spangles, especially near the bottom of the tube.

SILVER.

7-8. Silver, native.

Found in various rocks and minerals as nuggets, threads, thin sheets and branching masses; sometimes in very small particles in galena, copper pyrites and other ores, the value of which is thus increased. In the Thunder Bay district native silver and other ores are found in veins of white quartz and calcite. Native silver is often black or brownish in color, as it tarnishes readily in the air. It can often be recognized by catching the finger like ends of wire when the specimens are rubbed. It has been found at Silver Islet, Port Arthur, and in the Thunder Bay district in the Beaver mine, the Silver Mountain mine, the Badger mine, etc, where it is associated with zinc-blende, galena and argentite. On Calumet island near Bryson, Quebec, leaf silver is found in small quantities. Native silver usually contains gold, and sometimes copper or iron. The pure metal is worth at present 65 cents an ounce Troy. Ores of Silver.

9. Argentite, or Silver Sulphide—Ag_2S.

When pure contains 87 per cent. silver. It is blackish lead-gray, soft and heavy. It melts easily, even in a candle flame. When scattered through a dark rock it might be easily overlooked. It is one of the most abundant ores of silver, and is found along with native silver at the Beaver mine and other mines in the Thunder Bay district. It is found abundantly in the famous Comstock lode, Nevada. This ore, like other silver ores, is found in the greatest variety of rocks. It is often accompanied by native gold.

10. Pyrargyrite, or Ruby Silver ore—Ag_3SbS_3.

When pure contains about 60 per cent. of silver. In large pieces it is sometimes grayish-black in appearance, but when thin enough to let light shine through, it is seen to have the usual deep red color. It is also red when finely powdered, as seen by rubbing a little of it on a white plate. It is brittle and heavy. It is generally found along with other silver ores,

and with galena and arsenic. Proustite, or light ruby silver ore, Ag_3AsS_3, when pure contains $65\frac{1}{2}$ per cent. of silver. It is like pyrargyrite, but light in color.

11. Tetrahedrite, or Fahl ore—$4Cu_2S.Sb_2S_3$.

Varies greatly in composition. Sometimes contains no silver ; sometimes as much as 31 per cent. When it contains no silver it may be of value on account of its antimony, copper, or perhaps mercury. In color it varies from gray to black. It is often an inconspicuous mineral and easily passed over. It has been found at Capelton, Quebec, and in the township of Barrie, Frontenac county, specimens from the latter locality assaying as high as from 200 to 400 ounces of silver to the ton.

12. Meneghinite—$4PbSSb_2S_3$.

Closely related to tetrahedrite. Found in the township of Barrie.

13. Bournonite—$PbCuSbS_3$.

May contain as high as 15 per cent. of copper and a paying quantity of silver. It is a bright metallic mineral ; color, steel gray to black. It has been found in eastern Ontario.

14. Cerargyrite, or Horn Silver—AgCl.

When pure contains 75.3 per cent. of silver. Grayish, greenish, or colorless, but turns violet, brown, or nearly black when exposed to light. It is very soft and cuts easily. Usually found in veins of clay-slate ; but also with brown iron ochre, and with copper ores. It has been found in calcite.

LEAD.

Ores of Lead. The principal ore worked for lead alone is galena ; but as the pure metal ready for manufacture is worth only about \$60 a ton, the reduction of its ores will pay only under favorable circumstances. Lead ores are quite commonly reduced for the silver which they carry, the lead being produced as a by-product.

15-17. Galena, or Lead Glance—PbS.

Contains, when pure, $86\frac{1}{2}$ per cent. of lead. Always contains more or less silver, from a fraction of an ounce a ton upwards. It is a bright lead-colored mineral, brittle, and very heavy. It usually breaks readily into cubical fragments. It is commonly found in limestones and is often accompanied by ores of zinc and copper. It is found in many parts of the Province ; but not in sufficient quantities to work for lead alone.

18. Cerussite—$PbCO_3$.

White, gray, grayish black, yellow brown, occasionally tinged blue or green. Like other lead ores it is heavy. It is mostly accompanied by galena. It may yield 75 per cent. of lead. When mined along with galena it has sometimes been thrown aside as gangue rock of no value, a mistake due to its resemblance to worthless light colored minerals.

19. Anglesite, or Lead Vitriol—$PbSO_4$.

A heavy white, gray or green mineral, of glassy lustre. It contains about 68 per cent. of lead. It is usually found with galena, and is so far an unimportant ore.

ANTIMONY.

The principal ore of antimony is stibnite, but other antimony minerals would be valuable if found in sufficient quantities. Antimony ores when mined average in price about $35 a ton. Antimony is worth seven cents a pound. It is used in making tartar emetic, antifriction alloys, pewter, type metal, etc. Ores of Antimony.

20. Stibnite, or Antimony Glance—Sb_2S_3.

A lead-gray or steel-gray mineral, of a bright metallic lustre. It is sometimes in radiating masses of crystals, sometimes finely granular. It splits and breaks easily. It fuses easily even in a candle flame. It is found with quartz or calcite in beds or veins in granite and gneiss. Gold, zinc-blende, galena, cinnabar and barite are sometimes found with it. Sometimes also it contains silver. If the ore carries less than 30 per cent. of antimony it does not usually pay to mine it for this metal alone. This mineral has been found at several places in New Brunswick, in Hants county, N. S., in British Columbia, and in small quantities in Ontario.

21. Jamesonite, or Feather Ore—$Pb_2Sb_2S_5$.

Sometimes rich in silver. Takes its name of feather-ore from the feather-like masses of crystals in which it is sometimes found. It is a dark, lead-gray or steel gray mineral of metallic lustre It is somewhat heavy and brittle, although soft. It has been found in Barrie township, Frontenac county, where it is associated with minerals rich in silver.

BISMUTH.

The principal ore of this rare metal is native bismuth (No. 22); but bismuth ochre, bismite and bismuthinite (No. 23) may also be considered ores. Bismuth is used for making fusible alloys, and for manufacturing medicines. It sells at from $1.30 to $1.80 a pound. Ores of Bismuth.

22. Bismuth, native—Bi.

A silvery-white metal with a reddish-purple tint. It is heavy and somewhat soft and brittle. It has been found so far only in small quantities in veins in gneiss and other crystalline rocks. Bismite, or Bismuth ochre Bi_2O_3, is an earthy mineral, color greenish yellow to grayish white. It is sometimes found along with native gold. When pure it contains 89.6 per cent. of bismuth.

23. Bismuthinite, or Bismuth Glance—Bi_2S_3.

Lead gray to tin white; metallic lustre, sometimes with yellowish or iridescent tarnish. It is usually found in fibrous or foliated (like leaves of a book) masses of crystals. It is extremely soft and breaks with even surfaces. It resembles galena, but is much softer. When pure contains 81.2

per cent. bismuth. Found in Madoc, Hastings county, in Barrie, Frontenac county, and in the Mikado mine, west side of Lake of the Woods.

ZINC.

Ores of Zinc. The principal ores of zinc are sphalerite or zinc-blende, smithsonite and calamine. Their average value at the mine is $20 a ton. The metal is quoted at 3¾ cents a pound. Zinc ores sometimes carry silver and gold.

24-25. Sphalerite, or Zinc-blende—ZnS.

Sometimes called black-jack (No. 25) when very dark. It varies in color from pure white (rare) to black, but is usually of a yellow or brown color, with a resinous lustre. Ontario specimens are commonly black, or nearly so. It sometimes closely resembles galena. It rubs up to a white, yellow, or brownish powder, while galena produces a black or dark-gray powder. Sphalerite, which resembles galena, can be distinguished from it by the fact that when viewed in certain directions it loses its metallic lustre. It may contain silver, gold, cadmium or mercury. It is often mixed with galena. Occurs in both crystalline and in sedimentary rocks. It has been found in the Thunder Bay district, on Calumet island, in Beauce county Q., in Pictou county, N. S., and near Vancouver, B. C. It is a very common vein mineral.

26. Smithsonite, or Zinc Spar—$ZnCO_3$.

A brittle mineral, varying in color from white to brown. It may even be bluish or greenish. When pure, it is white. It may be clear and transparent, dull and granular, or soft and earthy. It is often found along with zinc-blende and galena. It usually occurs in calcareous rocks, associated with calamine or limonite. It may be colored bright yellow by greenockite, CdS. It often contains cadmium, which increases its value.

27. Calamine, or Zinc Silicate—$Zn_2SiO_4.H_2O$.

White, bluish or greenish, sometimes yellowish or brownish. It grinds to a white powder. It is generally somewhat transparent. Usually found with smithsonite, zinc-blende and galena, in beds or veins in calcareous rocks. It is sometimes found mixed with clay. It has been found at Ainsworth, West Kootenay, B. C.

28. Willemite.

Also a silicate of zinc, greenish yellow in color. In the specimen in the collection it is mixed with franklinite.

29. Zincite, or Red Zinc ore—ZnO.

Orange yellow and deep red. When pure, contains 80.3 per cent. of zinc. Pure zinc oxide is white. The red color of this ore is due to an oxide of manganese or iron.

TIN.

30-31. Cassiterite, or Tin Stone—SnO_2.

A heavy mineral varying in color from white to black, but usually brown or black. When it occurs in rock it is called tin-stone (No. 30); when in the form of sand or gravel, stream-tin (No. 31). Wood-tin is the same ore in

rounded masses, looking somewhat like dry wood in structure. It is so hard that it cannot be scratched with a knife, and is very heavy. Its lustre is never metallic, but is usually somewhat resinous. It is found in coarse granite (pegmatite). This granite contains white mica, with quartz and sometimes felspar. Tinstone is associated with a great variety of minerals, including wolframite (No. 81), scheelite (No. 80), topaz (No. 180), tourmaline (No. 176), molybdenite (No. 83), bismuth (No. 22), apatite (No. 111), arsenopyrite (No. 107), etc. This is an ore which the prospector might very easily pass over unnoticed. As tin is worth about $250 a ton, a small percentage of the mineral makes a paying ore. It has been found in small quantities near Sudbury, and may be looked for in some of the numerous pegmatite dikes which cut the Archæan rocks of Ontario.

32. Stannite, or Tin Pyrites—SnS_2.

Containing iron and copper. Steel-gray to iron-black. It sometimes looks like bronze or bell-metal. It has been found in veins in granite, generally accompanied by sphalerite and galena.

MERCURY.

The principal ore of mercury is cinnabar (No. 33), but it is also found native in fine droplets scattered through rock. It is also sometimes a constituent of tetrahedrite (No. 11), from which it is extracted along with other valuable constituents. Mercury is quoted at 40 cents a pound, or $38 a flask of 100 lb.

Ores of Mercury (quicksilver).

33-34. Cinnabar, or Sulphide of Mercury—HgS.

Contains 86.2 per cent. of mercury. Red, brownish red, or grayish red. Usually mixed with clay, iron oxide or bitumen. It resembles somewhat red hæmatite in appearance, but is heavier. It sometimes occurs in hæmatite, when it would easily be overlooked. Found usually in veins in slate and shale ; sometimes in granite and porphyry. Barite, chalcopyrite, stibnite, realgar, gold, etc., are found with it. The gangue minerals are quartz (or opal), calcite, etc. In British Columbia it is found at the Ebenezer mine, Kicking Horse Pass, disseminated through crystalline limestone.

COPPER.

The copper ores include a great variety of minerals. Besides Nos. 35-44, several minerals which, like bournonite, may be worked for other valuable constituents, yield copper as a by-product. The market price of copper at present is 11½ cents a pound.

Ores of Copper.

35-36. Copper, native—Cu.

Usually very pure. The native copper of the Lake Superior copper mines is nearly as pure as that refined by electrolysis. It sometimes contains silver, bismuth, mercury and other metals. It is found commonly in association with trap rocks in the lake Superior district. Found also in small quantities in eastern Ontario.

37. Chalcopyrite, or Copper Pyrites—$CuFeS_2$.

When pure contains 34½ per cent. of copper. Brass-yellow in color, sometimes tarnished with various shades. It grinds up to a greenish-black powder. It resembles pyrite in appearance, but is readily distinguished by its deeper yellow color and its softness, being easily scratched with a knife, while pyrite is untouched. On decomposing it stains the surrounding rock green or blue. It sometimes carries gold and silver. It is often accompanied by pyrite and pyrrhotite. Is found in many places in Ontario and Quebec, e.g., Sudbury, Bruce Mines, Pointe-aux-mines, near Sherbrooke, etc.

38. Bornite, or Purple Copper ore—Cu_3FeS .

Also called variegated copper ore, horseflesh ore and peacock ore. The pure mineral contains 55.5 per cent. of copper, but the composition varies. As high as 70 per cent. of copper has been found in some varieties. A brittle mineral between coppery red and brown in color on a fresh surface; but it soon tarnishes and then shows a rich variety of colors. It grinds to a pale grayish-black powder. It is one of the most valuable ores of copper, and is commonly found with other copper ores. It is found at Bruce Mines, lake Huron, at Parry Sound and elsewhere.

39. Chalcocite, or Copper Glance—Cu_2S.

Also called gray copper ore. When pure contains 79.8 per cent. copper. It sometimes contains silver. Blackish lead-gray, often tarnished blue or green. It can be cut readily with a knife. It is found along with bornite and other copper ores at most of the localties already mentioned. It is one of the richest ores of copper, but on account of its dull color is not so conspicuous as those already described.

40-41. Cuprite, or Red Copper ore—Cu_2O.

When pure contains 88.8 per cent. copper. A crystalline, granular or earthy mineral, color varying from cochineal-red to nearly black. It is found in shale, trap and sandstone, with other copper ores. In Michigan and Nova Scotia it is found with native copper. Chalcotrichite, or plush copper ore, is a variety of cuprite, massed in hair-like crystals.

42. Malachite, or Green Carbonate of Copper—$CuCO_3.Cu(OH)_2$.

Contains 57½ per cent. of copper. A mineral of a bright green color. Earthy, glossy, or silky in appearance. When hard and banded in different shades it is highly ornamental if polished. It often forms as a coating on other copper ores, when they are exposed to the atmosphere. The green color then calls attention to the presence of copper. This ore is the same in composition as copper rust. It is usually found with the sulphide and other ores of copper.

43. Azurite, or Blue Carbonate of Copper—$2CuCO_3Cu(OH)_2$.

Closely related to malachite, but contains a little less copper, viz., 55.3 per cent. It is usually a fine azure blue in color, and is commonly mixed with malachite. The finest specimens come from the Copper Queen mine, Bisbee, Arizona.

44. Chrysocolla.

Contains from 19 to 30 per cent. of copper. When pure, which it rarely is, it has the composition $CuSiO_3$, $2H_2O$. In color it varies from green to blue, and when very impure it is even brown or black. It accompanies other copper ores, being found especially at or near the surface. Its presence may thus call attention to the presence of copper ores, the green color being conspicuous like that of malachite.

NICKEL.

Nickel being worth at present from 30 to 40 cents a pound, it pays to extract small percentages from ores. Two or three per cent. can be extracted with profit. The cost of extraction depends largely on the composition of the ore. Nickel compounds are widely diffused in Ontario, and as the demand for nickel increases it will be well to explore for deposits of its ores. Nickel sells at present (1897) at 35 cents a pound. Ores of Nickel.

45. Pyrrhotite, or Magnetic Pyrites.

This is the mineral mostly worked for nickel in Ontario. Many deposits of pyrrhotite contain no nickel. They have the composition Fe_7S_8. At Sudbury from two per cent. upwards of the iron is replaced by nickel. Pyrrhotite may also contain a little copper and cobalt. Color, between bronze-yellow and copper-red, but tarnishes quickly to a liver color. It grinds to a grayish black powder. It is attracted by the magnet. At Sudbury the pyrrhotite is associated with copper pyrites, and with pentlandite and other nickel ores. The country rock is greenstone (altered norite and gabbro). Pyrrhotite has been found in many other places in Ontario.

46. Pentlandite—[FeNi]S.

Resembles pyrrhotite, but has a smooth cleavage. and a higher color. It is found in the Sudbury nickel ores mixed with pyrrhotite. It sometimes contains 30 per cent. of nickel.

47. Millerite, or Sulphide of Nickel—NiS.

A rather rare mineral, usually occurring in hair-like crystals, sometimes massed or woven, sometimes closely packed into rounded masses coating other materials. In color it varies from brass-yellow to bronze-yellow. It has so far not been found in large enough quantities to be of importance as a nickel ore. It has been found in calcite in Orford township, Quebec.

48. Gersdorffite, or Nickel Glance—NiSAs.

Contains 35.4 per cent. of nickel. It sometimes carries bismuth, copper and antimony ; also iron and cobalt. It is metallic-looking, and of a silver-white to steel-gray color. It accompanies other nickel ores as well as copper pyrites. It has been found in Denison township, and at Sudbury.

49. Niccolite, or Copper Nickel.

Composed of nickel and arsenic, NiAs. A hard, pale, copper-red mineral, usually tarnished on the surface to gray or black. It often accompanies silver and copper ores.

50. Chloanthite—$NiAs_2$.

Usually contains cobalt and iron. May be rich in silver, and sometimes contains small quantities of bismuth. It it tin-white in color, sometimes inclining to gray. It occurs in veins with other ores of nickel, and with ores of cobalt, silver and copper.

51. Garnierite.

A compound of nickel oxide, magnesia, silica and water It is a soft, bright green mineral, sometimes nearly white. It has a soapy feel, like soapstone. The percentage of nickel varies from 2 to 35 per cent. It is found chiefly in New Caledonia, where it is mined extensively; also in Douglas county, Oregon. As nickel compounds are widely disseminated in Ontario, it is quite possible that this valuable ore may yet be found here, probably associated with steatite (Nos. 159 and 160).

COBALT.

Ores of Cobalt.

Nickel ores commonly contain cobalt, which is separated in the process of extracting the nickel. But smaltite (No. 52), cobaltite (No. 53) and a few others may be considered cobalt ores. Cobalt is very like nickel, but has a purplish tint. It is used in making ornaments; and some of its compounds are used as coloring matters (smalt, etc.), and in chemistry.

52. Smaltite—$CoAs_2$.

Very like chloanthite. Usually contains nickel. Has been found in McKim township, Algoma, and also in Madoc.

53. Cobaltite, or Cobalt Glance—CoAsS.

May contain nickel and iron. It is silvery white, with a reddish tinge. When the proportion of iron is high it may be steel-gray or even black.

54. Erythrite, or Cobalt-bloom—$C_3As_2O_8.8H_2O$.

Usually occurs as a reddish or purplish coating on other minerals. Unimportant except as a guide to other cobalt and nickel minerals, with which it may be associated. Occurs at Silver Islet, also in Hastings county near Madoc.

IRON.

Ores of Iron.

The value of iron ore depends (1) on the percentage of iron, (2) on its freedom from sulphur, phosphorus and titanium, and (3) on presence or absence of other metals such as manganese, nickel and chromium, which give superior qualities to the iron. Ores containing 50 per cent and upwards of iron may be considered rich. The iron ores of Ontario include magnetite, hæmatite and bog ore. Pig iron sells at about $10 a ton. The ores bring prices (according to their richness and purity) averaging about $2 50 a ton.

55-56. Magnetite, or Magnetic Iron ore—Fe_3O_4.

Bright heavy iron-black mineral, attracted by the magnet. It contains 72.4 per cent of iron when pure. Sometimes, as at Bedford, Ont., the broken surface shows large smooth crystal surfaces (No. 56). In other specimens the surface is granular and somewhat dull. It is found in crystalline rocks.

57. Magnetite, Magnetic Sand.

Grains of magnetite usually mixed with small garnets, and sometimes containing gold, platinum, galena and other heavy minerals.

58. Magnetite, Lodestone.

Same composition as ordinary magnetite, but attracts iron.

59. Ilmenite, or Titanic Iron ore—$FeTiO_3$.

Also called menaccanite. It contains 36.8 per cent of iron. The high per cent. of titanium (31.6), as well as the low per cent. of iron, have so far rendered it useless as an iron ore. It is only slightly magnetic, but resembles magnetite in appearance.

60-61. Hæmatite, or Red Iron ore—Fe_2O_3.

Contains 70 per cent of iron when pure. Easily recognized by its red color. There are however varieties of hæmatite (Nos. 61 and 62) which are black, or nearly so. But they all grind up to a reddish powder. Sometimes it is slightly magnetic. It is found in rocks of all ages.

62. Hæmatite, Specular Iron ore.

Known by its bright surface. In large scales, or sometimes in small scales resembling mica (micaceous hæmatite). It is usually steel gray, but sometimes distinctly red. The streak of hæmatite, of whatever variety, is always red.

63. Hæmatite, Clay Iron-stone variety.

An impure variety of hæmatite, mixed with hardened sand or clay. It is very hard, and red, brown or nearly black in color.

64. Hæmatite, Red-ochreous variety.

Also called red paint. Usually found mixed with clay.

65. Limonite, or Brown Iron ore—$2Fe_2O_3.H_2O$.

Usually in masses having rounded surfaces. It is occasionally earthy. In color it varies from yellowish brown to dark brown. It may contain as high as 60 per cent. of iron, but usually less. The bog ore variety, mentioned below, is the first stage in the formation of the more solid brown iron ore.

66. Limonite, Bog-ore variety.

Gathers in the bottoms of lakes and bogs, being washed out of the surrounding rocks and thus concentrated. At first soft, it gradually hardens into lumps. It is abundant in some parts of Ontario. At Radnor Forges, Quebec, it has long been used for making a superior quality of charcoal iron.

67. Limonite, Yellow-ochre variety.

Often mixed with clay, etc.

68. Siderite, or Spathic Iron ore—$FeCO$.

Also called carbonate of iron and iron spar. When pure it contains 48.2 per cent. of iron. It is often found in masses which split like calcite, but other specimens are granular, earthy or fibrous masses, with rounded surfaces. Color varies. It grinds to a white powder.

69. Ankerite.

Resembles siderite, but contains only from 8 to 12 per cent. of iron, being largely composed of calcium carbonate and magnesium carbonate. It is valuable as a flux in blast furnaces, being used instead of limestone. It is usually lighter in color than siderite, being often white.

70. Chromite, or Chrome Iron ore—$FeO.Cr_2O_3$.

Contains 25 per cent. of iron and 46.7 per cent. of chromium. Color, iron-black or brownish-black. It looks somewhat like magnetite, but it grinds to a brown powder, while magnetite gives a black powder. Only slightly magnetic. Valuable as an iron ore to mix with other ores, as the chromium gives toughness and hardness to steel. It is also used in the manufacture of potassium bichromate ("bichrome"). The prices paid for chrome iron ore average $12 a ton at the mine.

MANGANESE.

Ores of Manganese.

Manganese ores are sought for mixing with iron ores, for various chemical manufactures, and for glass-making. Pyrolusite (No. 71) is quoted at $6.50 a ton.

71. Pyrolusite, or Black Oxide of Manganese—MnO_2.

A blackish mineral, often bright and shining, but sometimes dull. It is often in radiating crystals. It is heavy, soft, breaks easily, and soils the fingers. It is found at several places in New Brunswick and Nova Scotia, and is mined extensively at Tenny Cape, N. S. It is used to generate chlorine in the manufacture of chloride of lime, in the manufacture of glass, and for other purposes. Wad, or bog manganese, is a dark mineral varying from hard and compact to soft and earthy. It has the same origin as limonite, and is sometimes used to mix with iron ores.

72. Hausmannite—Mn_3O_4.

A brownish-black mineral, sometimes bright, sometimes dull and granular. It is found along with other manganese ores in porphyry.

73. Rhodochrosite, Manganese Spar, or Red Manganese ore—$MnCO_3$.

Color, rose-red, yellowish-gray, fawn-colored, dark-red, brown. The rose-red varieties somewhat resemble pink calcite. May contain up to 40 per cent. iron carbonate. (See Siderite, No. 68). The specimen in the collection has embedded in it fine cubes of pyrite.

ALUMINIUM.

Ores of Aluminium.

The principal minerals used in the manufacture of the metal are bauxite, cryolite and corundum.

74. Bauxite—$Al_2O_3.2H_2O$.

Usually with considerable oxide of iron. White, grayish, yellow, brown or red, according to the proportion of iron oxide. It occurs in grains or small lumps, or in masses resembling clay. When pure it is used for the manufacture of aluminium, and is then worth about $4 a ton.

75. Cryolite—$Na\ AlF_6$.

A mineral which when moistened looks very much like ice or compressed snow, although it is sometimes reddish. Has been found in very few localities. Is imported from Greenland for use in the manufacture of soda and aluminium. It occurs in veins in granite and gneiss. At Pike's Peak, Colorado, it is associated with zircon and columbite.

76-77. Corundum—Al_2O_3.

A very hard somewhat heavy mineral, white, gray, blue, red, yellow, or brown in color. In hardness it comes between topaz and diamond. It will scratch quartz crystals. Sapphire and ruby are pure crystallized corundum. Corundum has lately been found in Carlow, Hastings county, in Methuen, Peterborough county, and other localities. It is valuable as an abrasive (grinding and polishing) material and is quoted at from $50 to $150 a ton.

78. Emery.

An impure variety of corundum; is usually found mixed with magnetite or hæmatite. It is blackish and granular and somewhat resembles magnetite.

79. Alunite, or Alum-stone.

Similar to alum in composition. It is a white, grayish, or reddish mineral, solid and rocky, but sometimes soft and earthy. It is found in seams in rocks of volcanic origin, and is used in the manufacture of alum.

RARE MINERALS.

The specimens Nos. 80 to 86 inclusive are rare minerals, found only in small quantities, and used for a few special purposes. New applications are being found for them as their properties become better known, and their discovery in much larger quantity is quite within the range of possibility. This possibility is shown by the recent discovery in Norway of a locality producing the very rare mineral clèveite in much larger quantity than ever discovered before. As our crystalline rocks are very like those of Norway, search should be made here for these minerals. Various rare minerals.

80. Scheelite, or Tungstate of Lime—$CaWO_4$.

A heavy, crystallized mineral, white, yellowish, brownish, greenish, or reddish in color. It is found in crystalline rocks, in quartz associated with tin-stone, topaz, fluorite, apatite and wolframite. It has been found in Beauce county, Quebec, associated with galena, sphalerite, pyrite, etc. It is used in the manufacture of tungstic acid, tungsten and ferro-tungsten. Tungsten steel has superior hardness and durability. Tungsten sells at 70 cents a pound.

81. Wolframite—$FeWO_4$ with $MnWO_4$

Tungstate of iron and manganese. A heavy grayish, brownish, blackish, or brown red mineral, coarsely granular, or in layers, or columnar. It is often associated with tin-stone, bismuth, scheelite, pyrite, galena, etc.

82. Wulfenite, Lead Molybdate—$PbMoO_4$.

Often occurs in yellowish or red crystals; also in granular masses. The color is very variable, but most commonly yellowish or reddish. It is found in veins with other ores of lead, and is valuable for the manufacture of molybdic acid, used in chemical analysis.

83. Molybdenite, Molybdenum Sulphide—MoS_2.

Resembles graphite very closely but is heavier, and rather lighter in color. It is found in eastern Ontario. Used in manufacturing molybdic acid.

84. Uraninite, or Pitch-blende.

A rare mineral containing uranium and other rare elements. It varies in color from grayish to greenish, brownish, and velvet-black. Hardness, 5.5. In specific gravity it varies from 6.4 to 9.7. It is found in granites and allied rocks, and also in mineral veins. Clèveite and bröggerite are allied minerals. Clèveite is quoted at present at $5 a pound. Pitch-blende is used in the preparation of uranium glass (canary glass), and of certain chemicals. These minerals may be found in Ontario. Uraninite has already been found at the Villeneuve mica mines, Ottawa county, Que.

85. Monazite.

This mineral is valuable on account of its containing the element thorium, the oxide of which is used in the Welsbach system of incandescent lighting. It is brownish-red or yellowish-brown, and is commonly found forming beds of sand along with other heavy minerals. Whether occuring in sand or as a constituent of solid rock, it may be easily passed over, being mistaken for some valueless mineral. Thorium minerals are often associated with zircon, and as this mineral is found widely distributed in eastern Ontario there is a probability of the thorium compound being found in the same class of rocks. Monazite has been found in gneiss and other metamorphic rocks. It has been found in the Province of Quebec. Monazite is a good example of a mineral for which there was no industrial use a few years ago, but which is now an important commercial product. It sells for over $100 a ton.

86. Columbite, or Tantalite.

A rare mineral containing the elements niobium and tantalum. It is iron-black, grayish, or brown-black. It is heavy (5.3 to 7.3), hard and brittle.

CARBON.

Forms of Carbon.

Graphite, diamond and coal are more or less pure forms of the element carbon, diamond being the purest.

87. Diamond.

Identical in composition with graphite, but contains usually less impurity. Colorless diamonds are the most valuable. The color may be almost any shade from white to black. Black diamonds, or bort, are used in diamond drills. It is found mostly in gravel, sand, or clay, associated with quartz, gold, platinum, zircon, and in itacolumite or flexible sandstone. There is a probability of this mineral being found in northwestern Ontario.

88 90 Graphite, or Plumbago.

This well known substance is found sometimes in layered or scaly masses, sometimes granular or earthy in appearance. It occurs in granite, gneiss, mica-schist, and crystalline limestone. The value of graphite depends largely on its purity. It is used for lead pencils, stove blacking, as a lubricator, and in the manufacture of furnace pots. The average price at the mine is $10 a ton. It is found in abundance in eastern Ontario.

91-92. Anthracite, or Hard Coal.

Contains from 80 to 95 per cent. of carbon. All true coals are found in beds in strata which were laid down when the vegetation was large and luxuriant, and when the higher forms of the animal kingdom were beginning to appear. The combustible material found near Sudbury appears from a chemical analysis recently made by Mr. Wm. Lawson to have a composition similar to anthracite, but it has probably originated from petroleum.

93. Bituminous Coal, or Soft Coal.

Differs from anthracite in having usually a smooth cleavage, in being more easily broken, and in softening more or less when heated. It burns with a smoky, luminous flame, while anthracite burns with a clear bluish flame. This difference is due to the presence in bituminous coal of hydrogen compounds which distil as combustible gases as the coal heats up and burns. Bituminous coal usually leaves a higher percentage of ash than anthracite does. There are extensive soft coal areas in Nova Scotia, particularly in Cape Breton island.

94. Cannel Coal, or Parrot Coal.

Described as a variety of bituminous coal. It is much used for distillation in the manufacture of gas and coal tar.

95 Albertite.

Chemically allied to asphalt. It dissolves partly in oil of turpentine. It softens a little in boiling water. It is found as vein matter in Albert county, New Brunswick.

96. Anthraxolite.

Resembles coal very much, but is found only in small quantities in veins, or as a black coating on other minerals.

97. Lignite, or brown coal.

Called brown coal, although it is often black, like true coal. It represents a stage in the change of vegetable matter into true coal It has been found on the Moose river, and occurs abundantly in the Northwest territories. It has been extensively mined and used in the Souris valley.

98. Peat.

Is a brownish fibrous substance, easily crushed and broken when dried. The peat bogs of Ontario may become of the greatest economic importance as sources of fuel. By heating and compressing, peat can be converted into a hard coaly substance which makes as good fuel as anthracite.

99-100. Petroleum.

A liquid varying widely in color from colourless to almost black. Most commonly greenish brown. It is so light that it always floats on water. Sometimes it is thin and flows easily ; other specimens are thick and syrupy. Bitumen or asphalt is another stage of the same change. Petroleum consists of a large number of compounds of carbon and hydrogen, both combustible elements. It is therefore a first-class fuel. Some of these compounds are liquids ; others are solids and gases disoslved in the liquids. In refining, part of the liquid is distilled off and purified for burning oil. From the remainder, paraffin wax, vaseline and other products are made.

101. Asphalt.

Brownish black, or black ; has a bituminous smell. Melts in boiling water (albertite just softens), and dissolves almost completely in turpentine. It is sometimes found in the liquid condition. The great asphalt lake in Trinidad is filled with liquid asphalt, covered with a layer of the solid material.

102. Amber, or Succinite.

This is a fossil resin, occurring in association with coal and lignite, but also in clay soil, etc. It is believed to have been derived from the coniferous forests of past ages.

SULPHUR.

103. Sulphur.

Forms of sulphur.

Yellow when pure and crystallized, but may be nearly white when finely granular, also may be brownish or grayish from impurities. Easily known by its melting, catching fire, and burning with a blue flame when heated. It is found in beds of gypsum and in volcanic rocks. It is also found in small quantities associated with lead and other ores, in coal, and in lignite. Sulphur (crude) is at present quoted at $20 a ton. It is used principally in the manufacture of sulphuric acid, but as the price is rising it may soon pay better to use pyrites (No. 104) for that purpose.

104-104A. Pyrite, or Iron Pyrites—FeS_2.

This mineral is often mistaken for gold on account of its golden yellow color, but is hard and scratches glass easily. Color, pale brass-yellow, but it varies a little ak, greenish black or brownish black. It strikes fire, like flint. It often, but by no means always, carries gold. It is one of the commonest of minerals, being found in greater or less quantities in rocks of all ages. Quartz veins which carry gold quite commonly show also considerable pyrite, and the gold is often found most abundantly in the neighborhood of the pyrite or disseminated through it. It has been used a good deal in the manufacture of sulphuric acid.

105. Marcasite, or Cock's-comb Pyrite—FeS_2.

Has the same composition as pyrite, but differs from it in being a little softer, and in weathering more easily. It is also paler in color. On

exposure to the weather it soon falls to pieces, and gradually forms green vitriol and sulphuric acid. Iron pyrites undergoes a similar decomposition, but more slowly.

ARSENIC.

Nos. 106 to 110, inclusive, represent ores of arsenic, the most important being mispickel (No. 107). The ores are worked for the element arsenic, used to alloy with lead in making shot and bullets. It hardens the lead, and is used for the same purpose in other alloys. Arsenic ores are also worked for white arsenic, commonly called arsenic, used in making Paris green, etc. Arsenic ores.

106. Leucopyrite, or Arsenical Iron—FeAs

Silver white to steel gray, and of metallic lustre. Sometimes carries gold. Heavy and brittle ; somewhat like mispickel. Varies in composition.

107. Mispickel, Arsenopyrite, Arsenical Pyrites—FeS.As.

Color silver white to steel gray ; $h = 5.5$ to 6 ; $g = 5.9$ to 6.2. The pure mineral contains 46 per cent. of metallic arsenic, and yields on roasting about 60 per cent. of white arsenic, a valuable product, the present selling price of which when purified is about $50 per short ton.

108. Arsenic, native—As.

A whitish metal, which soon tarnishes to a dull blackish gray. It is quite brittle and gives a tin-white streak, soon tarnishing to a dull gray. It is not common, but sometimes accompanies ores of antimony and silver. It may carry silver, gold or bismuth.

109. Realgar, or Red Sulphide of Arsenic—AsS.

Color reddish orange to orange-yellow. May be transparent or nearly so. It is soft and easily cut with a knife. It occurs with other arsenic ores, and with ores of silver and lead.

110. Orpiment, or Yellow Sulphide of Arsenic—As_2S_3.

A soft, easily cut mineral of a golden or lemon yellow color. It occurs along with realgar in mineral veins. When in large enough quantities both these minerals can be worked as ores of arsenic.

PHOSPHATE, GYPSUM, etc.

111-114. Apatite, or "Phosphate"—$_3Ca_3(PO_4)_2$,CaCl or CaF_2.

Varies much in color ; usually greenish (No. 111) or reddish brown (No. 113), but sometimes colorless. Sometimes in well shaped crystals of the hexagonal system (No. 114). It is often associated with mica. In Canada it is commonly associated with pyroxene (No. 112), wilsonite, calcite (pink), sphene, garnet and zircon. It is found in abundance in eastern Ontario. Owing to the competition with other phosphatic minerals recently discovered in the southern States the present price is very low, averaging about $3 a ton. Some varieties of green pyroxene resemble apatite very closely. The pyroxene can be distinguished by its greater hardness, and by its insolubility in acids. Forms of calcium.

115. Phosphatic Nodule.

Mostly phosphate of lime. Varies from light gray to brown or even black. Found abundantly in South Carolina, Florida, etc. It is so easily mined that it has for the present driven Canadian apatite out of the market.

116. Gypsum, or Plaster Stone—$CaSO_4.2H_2O$.

White or gray in color ; very soft. In granular masses, sometimes translucent and fine grained (alabaster), sometimes of a satiny lustre (satin spar). When heated it loses part of its water and becomes plaster of Paris.

117. Gypsum, crystallized or selenite.

Clear, colorless transparent crystals, which very readily split into layers.

118. Anhydrite—$CaSO_4$.

Differs from gypsum by containing no combined water. It occurs usually with calcite or gypsum. It strongly resembles calcite in appearance, but roughens on the surface when exposed to the weather.

119-121. Calcite, or Calc Spar—$CaCO_3$.

Also called calcium carbonate and carbonate of lime. Very abundant mineral, forming beds of rocks, as limestone, marble and chalk. The pure mineral is found in transparent colorless crystals, or in white granular masses in rocks of all ages. It is often variously colored by impurities. A pink variety is often found. It easily splits into regularly shaped pieces having oblique angles. It is very common as vein matter.

122-124. Fluorite, or Fluor Spar—CaF_2.

Commonly in transparent crystals or crystalline masses, which are colorless, or variously colored by impurities. It is a common vein-stone. The colors are sometimes very beautiful, and the mineral is used for ornamental purposes. It is also used to generate hydrofluoric acid for etching glass, and sometimes as a flux for smelting.

HEAVY SPAR, ETC.

Forms of strontium and barium.

125-127. Celestite—$SrSO_4$.

Sky blue or white, sometimes reddish. Found in limestone and sandstone ; sometimes in beds of gypsum, rock salt and clay ; also with galena, sphalerite and other metallic ores. It is used in the manufacture of red fire and in other chemical manufactures Found in Methuen township, Peterborough, at Kingston, and in other parts of eastern Ontario.

128-129. Barite, or Heavy Spar—$BaSO_4$.

A heavy white mineral, sometimes colored by impurities. It may be granular, or in masses of wedge-edged crystals (No. 129). It is found in veins in limestones and sandstones, also associated with lead and other ores. It is used in producing green fire and in chemical manufactures. The pure white mineral is ground and used to adulterate white lead. Selling price at present is $5 a ton. Found widely distributed in mineral veins.

130. Withersite, or Barium Carbonate—$BaCO_3$.

A heavy mineral ; color, white, yellowish or grayish Found in veins associated with galena, silver ores, barite, etc.

DOLOMITE, SALT, ETC.

131. Magnesite, or Carbonate of Magnesia—$MgCO_3$.

In white, crystalline, granular or earthy masses. It is sometimes yellowish, grayish or brown from impurities. It is found in talcose schist, serpentine, gypsum, sometimes in veins, sometimes in scattered masses. Forms of magnesium and sodium.

132. Dolomite.

A mixture of carbonate of lime and carbonate of magnesia, crystallized together. The proportions vary. The mineral resembles crystalline limestone, but does not effervesce so readily with acids. It often has a pearly lustre. It is useful as a flux for blast furnaces, and for making Portland and other cements.

133. Halite, or Rock Salt—NaCl.

White, or colored yellowish, grayish, reddish or bluish with impurities. Sometimes in clear transparent masses of large size. It is commonly more or less mixed with gypsum, and with other impurities which by absorbing moisture from the air keep it moist. Occurs in beds in rocks of various ages. Salt springs or wells are often indications of salt beds at a greater or less distance.

ROCK-FORMING MINERALS.

Specimens 134 to 173 include those minerals (with their less common varieties) which are most commonly found as essential constituents of rocks. (Stilbite is not common). Calcite and dolomite, not included here, are also important rock-forming minerals. Many minerals are found widely distributed in rocks, but only in subordinate amounts. They are accessory constituents. Granites, for example, if examined in very thin sections or slices under the microscope, are found to contain microscopic grains or crystals of magnetite, apatite, zircon and other minerals. Essential constituents of rocks.

QUARTZ.

134. Quartz—SiO_2.

The pure substance is white, and either glassy and transparent or opaque white. It is often colored with impurities, reddish, brownish, grayish, etc. Quartz is one of the commonest constituents of rocks. It forms the gangue matter of many mineral veins. Gold is more commonly found in quartz veins than in any other situation. Quartz is an essential constituent of granite, gneiss, mica schist, sandstone, etc. It may be distinguished from other white minerals with which it is commonly associated by its hardness. It scratches glass easily and does not break with a smooth fracture. Forms of quartz.

135. Quartz, Rock Crystal.

Six-sided prisms capped by pyramids, commonly colorless and transparent. Large perfect crystals are of considerable value for ornamental and other purposes.

136. Quartz, rose variety.

137. Quartz, amethyst variety—SiO .

Amethyst of great beauty is found at Cape Blomidon, N.S., also in the lake Superior district.

138-139. Quartz, smoky variety, or Cairngorm—SiO_2.

From gray to brownish black in color. When free from fractures is cut and polished to gems. Very large crystals have been found at Paradise R., N.S.

140. Quartz, Agate—SiO_2.

A variety of chalcedony with a distinctly banded structure, the bands being of various colours, and in more or less perfect spheres, showing in circles when the stone is broken or cut and polished. In moss agate the colors are irregularly distributed in delicate branchings like moss. Agates are found in the lake Superior district.

141. Quartz, Chalcedony—SiO_2.

A variety of quartz occurring in rounded masses, having a somewhat waxy appearance and a layered structure. In color it varies from white to grayish, pale brown, brown and black. Chalcedony is found at Partridge island, and at Cape Blomidon, N.S.

142. Quartz, Opal, SiO_2, combined with a little water.

When showing a delicate opalescent play of colors it is of value as a gem.

143. Quartz, Jasper.

An opaque variety, usually red, but also rich yellow, and sometimes brown or black. It is sometimes found in large quantities in hæmatite deposits, in conglomerates, etc. Good specimens are obtained in the lake Superior region.

144. Quartz, Flint.

Somewhat like chalcedony, but darker and duller, from gray to brownish-black. Often white on the outside from the chalk in which it is found. Breaks with a smooth curved fracture and a sharp cutting edge.

145. Quartz, Hornstone.

Like flint, but more brittle. Chert is the name used to include flinty, jaspery and other impure siliceous rocks. Touchstone is a velvet-black variety of silica, used for testing the fineness of gold by the color of the mark left when the gold is rubbed on the touchstone.

THE FELSPARS, ETC.

Forms of felspar.

These minerals are usually divided into two groups, depending on their systems of crystallization. We thus have (a) orthoclase and (b) plagioclase. Orthoclase is also known as the potash felspar, and the term plagioclase stands for a group of felspars which are either soda, lime or lime-soda holding minerals. According to the percentage of soda or lime these minerals are known under various names, e.g., albite, oligoclase, labradorite and anorthosite. The commoner felspars are used as fluxes in smelting, and as a glaze for pottery. Value about $5 a ton.

146. Orthoclase.

A silicate of alumina and potash. Color, commonly white, gray or flesh red. Can be split or cleaved readily. May be mistaken for calcite or dolomite, but is much harder. It is found as a constituent of many rocks, such as granite, syenite and gneiss, and is a very common veinstone.

147-147A. Microcline.

Possesses the same chemical composition as orthoclase, but differs from it in crystallization. A green variety known as amazon stone is found at Pike's Peak, Colorado, and in eastern Ontario.

148. Albite.

Composed of soda, alumina and silica. It is the most acidic of the plagioclase, or in other words it is the plagioclase which contains the highest percentage of silica. Generally white in color; hence its name. In hand specimens it resembles orthoclase in many respects, and is found under the same conditions. Often series of very fine lines may be seen running across the surface of plagioclase crystals. In this way these crystals may sometimes be distinguished from those of orthoclase, but the two minerals are most readily identified when examined in thin sections under the microscope.

149. Perthite.

This beautiful substance is made up of orthoclase and albite, the two being interlaminated. The name was originally given to samples from a deposit near the town of Perth, Ontario.

150. Labradorite.

Composition, lime, soda, alumina, silica. It is a more basic plagioclase than albite, as it holds a lower percentage of silica. It has many characteristics similar to orthoclase and albite. It may be white, or nearly black in color. Some specimens exhibit beautiful shades of color when viewed in different directions, blue being the most striking. Named from its occurrence in Labrador. The finer kinds are valuable as ornamental stones.

151. Sodalite.

Is a blue or bluish green mineral taking the place of felspar in some rocks. It occurs with the rare rock nepheline-syenite in Dungannon, Hastings county. It has been used as an ornamental stone.

152. Scapolite.

This mineral is formed by the decomposition of basic plagioclase. In eastern Ontario it is found taking the place of the latter mineral in rocks which have been metamorphosed. It is also found as a vein mineral.

153. Wilsonite.

Is a pink variety of, or slightly altered form of, scapolite.

154. Kaolin.

White in color and earthy in appearance. This is an alteration product of felspar. It is pure clay, and is used in the manufacture of porcelain and for other purposes.

THE MICAS.

Forms of mica.

The most striking characteristic of this group of minerals is their flexibility. They may be separated into thin flakes which can be readily bent and are quite elastic. This characteristic distinguishes them from all other minerals, so that it is not necessary here to give any but a brief description of them. Pieces of mica sometimes occur of large size, and the mineral is used extensively in the arts. The colorless varieties (white mica) are the most valuable, and the larger and the more perfect the sheets into which it can be split, the greater its value. The average price for sheet mica is $1 a pound. Ground mica averages $94 a ton.

155. Muscovite.

In composition it is a potassium-aluminium-silicate, containing water. Usually described as potash mica. It is mostly white in color, and constitutes most of the white mica of commerce.

156. Phlogopite.

Similar in composition to muscovite, but contains magnesium ; hence described as magnesium-mica. In color it is quite commonly amber, and constitutes a large part of the amber mica of commerce, less valuable than white mica.

157. Biotite.

Magnesium iron mica. Commonly black in color.

158. Lepidolite or Lithium Mica.

A comparatively rare mineral, usually pink in colour. It often occurs in small flakes, and then has a somewhat granular appearance.

TALC AND PYROXENE.

159-160. Talc.

A silicate of magnesia containing water. It is soft (1 to 1.5), and can be easily scratched with the finger nail. It has a soapy feel. One variety, foliated talc (No. 159), can be separated into thin sheets like mica. It may be white or green in color, and has a pearly lustre. It is sometimes ground and used for making glazed paper. A massive variety, steatite, or soapstone (No. 160), also called potstone, is granular and white or grayish in color. It is sometimes soft enough to be used as chalk (French chalk). The average price of talc at the mine is $9 a ton. It has been found in Hastings, and also in Frontenac.

161. Pyroxene.

A silicate of magnesium and calcium, with small quantities of iron, aluminium, etc. It has many varieties, including diopside, diallage and augite. It varies in color from white to yellowish green (No. 112), brown and black. A massive green pyroxene has been mined by mistake for phosphate, and black pyroxenic rock for iron ore. It is harder than apatite and lighter than magnetite.

ASBESTOS, ETC.

162-167. Amphibole.

Similar in composition to pyroxene, but differing in crystalline form. The principal varieties are hornblende (No. 162 and 163), actinolite (No. 164) and tremolite (No. 165). Hornblende is usually black, actinolite green, and tremolite white or gray. All show a tendency towards a fibrous structure, the fibres being often arranged in a radiated mass in actinolite and tremolite. When the fibres are fine and somewhat silky, the mineral is true asbestos (No. 166), although in commerce the name is given to fibrous serpentine (No. 170 and 170A). Actinolite and tremolite are sometimes ground and made into a fireproof roofing material. Mountain leather, mountain cork (No. 167), and mountain wood are light, porous, elastic varieties of amphibole.

168-170. Serpentine.

A silicate of magnesium containing water. In finely granular or fibrous masses, smooth, and sometimes greasy in feel. In color, greenish, brownish or nearly white. It is most commonly greenish. It is rather soft (2 5 to 4). When the fibrous varieties are sufficiently long-fibred and tough they are called chrysotile, and constitute what is commonly sold as asbestos. It is doubtful if true asbestos free from water (No. 166) is now to be found in the market. The average price of serpentine asbestos at the mine is $18 a ton, but it varies much according to quality.

171. Stilbite.

A silicate of aluminium, calcium and sodium, containing a considerable percentage of water. It represents a class of minerals, zeolites, found mostly in cavities in basalt, diabase and other igneous rocks. They are often crystallized in beautiful radiating groups or masses.

172. Epidote.

A silicate of aluminium, calcium and iron, with a small percentage of water. Color, various shades of green to brown or black, but is commonly a peculiar yellowish green. It is hard and brittle, and has an uneven fracture. It is sometimes found in granite, etc.

173. Chlorite, or Prochlorite.

A silicate of aluminium, magnesium and iron with water. The specimen represents a group of rock-forming minerals, the chlorites, mostly of a green color. The specimens 174 to 180 are less common than the preceding, but some of them are of frequent occurrence in crystalline rocks. They are often found in well-shaped crystals, and many of them are valuable as gems.

GEM STONES, ETC.

174. Sphene, or Titanite—$CaTiSiO_5$.

A comparatively rare mineral, varying in color from the common brown varieties to gray, yellow, green, rose-red and black. Commonly in wedge-shaped crystals. It occurs in crystals in granite, gneiss, mica-schist, crystalline limestone, etc.; also in iron ores Very large crystals are found in Sebastopol township associated with apatite, amphibole and zircon.

174A. Zircon—$ZrSiO_4$.

Colorless, yellowish, grayish, greenish, brownish or reddish brown. Found in crystalline rocks. The finer transparent crystals are valuable as gems, and are known as hyacinths. A celebrated locality is in Sebastopol township, Renfrew, where very large crystals are found, but the gem variety has not yet been discovered. Zircon is also of considerable value as a source of the materials from which the mantles of the Auer incandescent gas light are made. As it is of frequent occurrence in our crystalline rocks, it may have undergone a natural concentration in the sands and gravels of some localities.

175-176. Tourmaline.

Composed of magnesia, alumina, boron and silica, with small amounts of soda, etc. Color, usually green, red, brown or black. When in crystals it often shows triangular cross-sections. Commonly occurs in granite. The black variety is known as schorl, and is often mistaken for coal.

177. Kyanite, or Cyanite—Al_2SiO_5.

A bluish mineral, crystallized in long bladed crystals with a smooth fracture, often blue along the centre and white along the margins of the blades. It is often associated with corundum.

178. Garnet.

A silicate of variable composition. Occurs in brittle roundish crystals, quite commonly of a reddish or wine color, but has a great variety of colors. The crystals are often quite regular, as if shaped and cut. Large crystals are common at Fort Wrangel, Alaska. Deep red transparent crystals are valuable as gems. Garnets are found in mica schists, gneiss, crystalline limestone, etc. The gem garnet is found mostly in serpentine and serpentine conglomerate.

179. Beryl.

Composed essentially of oxide of beryllium and aluminium, with silica. It often has a green color, and it is very hard. The bright green varieties are known as emerald, and are valuable as gems. When in crystals the cross-sections show a hexagonal outline.

180. Topaz—$Al_{12}Si_6O_{25}F_{10}$.

A hard, brittle mineral, usually of a straw-yellow color, but also white, grayish, greenish, bluish and reddish. Transparent or translucent. The more beautiful crystals are valuable as gems. It occurs in gneiss or granite, accompanied by tourmaline, mica, beryl, apatite, etc.

181. Ruby.

A variety of corundum, Al_2O_3, but well crystallized and colored red. It occurs in crystalline limestone, dolomite, gneiss, etc. It is associated with prochlorite, tourmaline, spinel, kyanite, etc. When the crystals are large and clear they are very valuable. Small crystals are said to have been found at Burgess, Ont. The best are found in Burmah, both in gravels and in rock.

182. Sapphire.

A variety of corundum, Al_2O^3, but in crystals and colored blue. It occurs along with rubies, and in the same formations. The finer crystals are valuable as gems. They are found in Ceylon and other eastern countries, usually in gravel or sand, accompanied by magnetite, spinel, etc.

183. Turquois.

A phosphate of alumina with water. Color, sky blue to green of various shades. It is rather brittle. It is found in seams in trachyte, clay slate and porphyry. The finer varieties are very valuable as gems.

184. Lapis-lazuli, or Lazurite.

A bluish mineral somewhat resembling sodalite, and closely allied to it. It was much valued as a blue paint, but is now made artificially as ultramarine by heating together sodium sulphate, sulphur, felspar and rosin.

PART III. ROCKS AND ROOK STRUCTURES.

By W. G. Miller.

Rocks of the earth's crust.

According to the commonly accepted theory the earth and the other members of the solar system were at one time in a fused or molten condition; hence the first rocks formed on our globe (through the cooling of the molten mass) belonged to the class which is known as the Igneous or heat-formed rocks. These rocks are still being formed through the cooling of fluid matter which rises from depths in the interior of the earth through fissures in the crust, to or towards the surface.

Igneous rocks.

After the molten material had solidified at the earth's surface, it would be acted upon by the atmosphere, water and other agencies, and be broken down to a greater or less extent to form gravel, sand or clay, just as we see masses of rock, such as cliffs, being worn down by these agencies at the present day. The materials thus formed, which are fragmental in nature, together with rocks formed by the deposition of the remains of plants and animals, make up the greater part of the class known as Aqueous or water-formed rocks. They are given this name on account of water being the chief agent in their formation. They are known also under the names sedimentary, fragmental and clastic.

Aqueous rocks.

The sorting action of water on the loose material into which rock masses are broken may be seen along the shore of any lake. The coarsest material, gravel, is deposited near the shore, while the sand is deposited in layers in deeper water, and the finest material or clay is deposited still farther from the shore line. Through the effects of pressure and cement substances these loose products are solidified in time into beds or strata of conglomerate sandstone and shale.

Metamorphic rocks.

If these aqueous rocks are subjected to greater pressure and heat, they become very compact and their characters are much altered. They become more or less crystalline in appearance and are then known as Metamorphic or altered rocks, or as the Crystalline schists.

We thus have three kinds, or three great classes of rocks, making up the crust or outer part of the earth, viz., the Igneous, Aqueous and Metamorphic rocks.

Metamorphic rocks are also formed from those of the igneous class through the agency of pressure and chemical action. Thus, while some gneisses are known to be altered aqueous rocks, it has been proved that others have been formed through the alteration or metamorphism of igneous rocks.

Forms of igneous rocks.

The earth is constantly losing heat and diminishing in size. The interior as it loses heat tends to shrink away from the external cool and solid crust. This causes the crust to become folded and wrinkled, as the cooling goes on. In places the side or lateral pressure on the folds becomes so great that they are cracked and broken across. The fissures or cracks thus formed in the crust sometimes reach to great depths, so that the highly heated matter of the interior finds a passage to the surface. On cooling it gives rise to surface-formed igneous rocks, or, as they are generally called, volcanic rocks. The material of which these are composed having been exposed at the surface of the earth cools quickly, after the manner of the molten material which is drawn from a furnace. Hence we find that volcanic rocks are often slag-like or glassy in appearance. Through the folding and rupturing of the rocks, the crust has fissures and cavities formed on its under surface. Into these spaces molten matter also makes its way, but here it loses its heat or cools slowly, and gives rise to rocks which are coarse grained and crystalline, and not glassy or slag-like in appearance. Igneous rocks of this class are called plutonic rocks, since they are formed deep down beneath the surface of the earth. There is also another class of igneous rocks, which is intermediate in character, or forms a connecting link between the volcanic and the plutonic classes. This class of igneous rocks is known as the dike rocks. They represent molten matter which has cooled in narrow fissures in the crust, and hence has lost heat through contact with the walls of the fissures more rapidly than did the matter which gave rise to the plutonic rocks, but not so rapidly as did the volcanic rocks. Dike rocks are usually much finer grained than those of the plutonic class, and some of the minerals of which they are composed often have a definite crystal outline, giving the rocks a porphyritic structure. They also differ from the volcanic rocks in not being glassy, and in other characteristics.

Volcanic rocks.

Plutonic rocks.

Some of the fissures formed by the fracturing of the earth's crust do not extend down to the highly heated interior, and hence are not filled with molten material. In course of time however most of these fissures are filled with mineral matter, which is deposited from solution in the waters which circulate through the crevices and openings in the rocks. The material thus

deposited forms what has been called vein rocks. These materials filling fissures are what is known as mineral veins. While dikes and fissure veins are similar in form, the latter are of aqueous origin, while the former are of igneous formation. Vein rocks.

It is natural that the older rocks should in most cases be more broken and fractured than the newer; hence veins are more frequently found in them. In the process of folding, openings are made between the beds of rocks, and moreover cavities are made in rocks through the solvent action of water. These openings and cavities are filled in the course of time in the same way as are some fissures, by the deposition of material from solution. We thus get mineral deposits or ore bodies of various forms Origin of mineral veins.

If a series of beds of rocks has been folded and then exposed to erosive or breaking down action, through the agency of water and the atmosphere, the tops of the folds may be worn off. We then get a structure such as is shown by the gneiss C in the following figure. Barriefield Common, Kingston

A= Limestone B= Granite. C= Gneiss. Q= Granite Quarry.

Section across Barriefield Common, Kingston.

A—Limestone (an aqueous rock.) B—Granite (an igneous rock). C—Gneiss (a metamorphic rock.)

Rocks of four ages are shown in the section, viz: gneiss; granite, which cuts through the gneiss and is therefore the younger of the two; limestone, which overlies both the granite and the gneiss and contains fragments of the former, and is therefore the youngest of the three; boulders and other loose material, which overlie the limestone and are hence the youngest rocks present.

Several common geological terms may be explained by means of the section, e.g. "contact," the point of junction of the limestone with the gneiss or granite; "unconformity," the beds of limestone lying on the upturned edges of the gneiss. The layers of the gneiss make an angle with the horizontal. The gneiss is therefore said to "dip" at a certain angle. The horizontal direction or the course of the upturned edges, which is perpendicular to the line of dip, is spoken of as the "strike." The granite appears at the surface of the ground, or forms an "out-crop." A mass of igneous rock exposed at the surface in a more or less rounded or irregular form is spoken of as a "boss." Narrow fissures in the gneiss are filled by granite. Such structures are known as "dikes." The foldings in the gneiss show "anticlines" or ridge-like forms, and "synclines" or trough-like forms. The bedded structure in the limestone is spoken of as "stratification," each bed being called a stratum. The gneiss shows a layer-like structure also, but the layers are not so regular as those in the limestone, and are more or less finely bent and crumpled. This structure in gneiss and other crystalline rocks is spoken of as "schistosity"—the rocks are said to Illustrations of geological terms.

have a schistose structure. The granite is not arranged in layers, and is called a "massive" rock.

IGNEOUS ROCKS.

Classification of igneous rocks.

The Igneous rocks may be divided as we have seen into three groups—plutonic, dike and volcanic. The members of each group are again subdivided, according to the percentage of silica they contain, into acid, intermediate and basic rocks. If a rock contains over 65 per cent. of silica, it is spoken of as an acid rock ; if its percentage of silica is between 50 and 65, it is said to be intermediate in composition. Rocks containing less than 50 per cent. of silica are said to be basic.

The names given to Igneous rocks, unless they are perfect glasses, depend on the minerals they contain—hence also on their percentage of silica—and on their structure, that is on the form and arrangement of their constituent minerals.

The following tabular arrangement of the Igneous rocks shows the way in which they are classified according to the description given above. Only the more commonly occurring rocks are shown in the table, and since many of the dike rocks have been but little studied, and are moreover difficult to determine without recourse to refined methods of investigation, their position is not shown in the table. The pink and light colored varieties of these may be simply called granite or syenite dike rocks, while the name "trap" may be applied in the field to the fine grained basic rocks, whose true character cannot be made out in hand specimens.

	Chief felspar=ORTHOCLASE		Felspar=PLAGIOCLASE	
	with usually MICA (or, and) HORNBLENDE (or, and) AUGITE.		with HORNBLENDE (or, and) MICA	with DIALLAGE.
	+ QUARTZ.	—QUARTZ.		
Plutonic.—(Structure=coarse grained.)	Granite.	Syenite.	Diorite.	Gabbro.
Volcanic.—(Structure=more or less glassy.)	Rhyolite. Obsidian. Pitchstone. Pumice.	Trachyte.	Andesite.	Basalt. Diabase.

The mineralogical composition of the plutonic rocks can be made out by a glance at the table ; e.g., it is seen that we may have a syenite which is composed of mica and orthoclase.

Each volcanic rock corresponds in chemical composition to the plutonic rock in the same column. Usually however the volcanic rocks are incompletely crystallized. They contain more or less glass, which is represented in the corresponding plutonic rocks by mineral grains.

There are no hard and fast lines between rocks. We find one group or class passing gradually into another. Thus, one might get a rock which could be called either a basic granite or an acid diorite. Hence too much stress should not be placed on a name. If we know the characteristics of a rock, that is, can give a description of it, it matters very little for our own convenience whether we give a name to it or not. A name serves merely as a short general description, but as many closely related rocks, varieties of granite for example, differ from one another in so many particulars, it is necessary for us if we wish to give the characteristics of a certain granite to state something more than its mere name. The characters of the Aqueous rocks are less difficult in most cases to determine than those of the Igneous class, and no tabular arrangement is required in their description. Some of the more common Aqueous rocks are conglomerate, sandstone, shale and limestone. The Metamorphic rocks also do not require a complex classification. Some of the more common members of this class are gneiss, mica schist, quartzite, slate and crystalline limestone.

About the names of rocks.

Only very brief descriptions are here given of the rocks in the catalogue. Kemp's Handbook of Rocks, (the author, Columbia College, New York, price $1.50), will be found a good book in which to read up details. This book also contains an excellent glossary of the names of rocks and of other lithological terms.

185 and 186. Granite. Granites are coarse grained rocks, color gray or light red, and are composed typically of quartz, orthoclase, or other acid felspar, and mica, biotite and muscovite. Mica may be replaced in whole or in part by hornblende. The ferromagnesian constituents, biotite and hornblende, in granite are often decayed, and the felspar is often altered to kaolin, or clay, when the rock has been subjected to atmospheric influences. The value of a granite mass for industrial purposes depends on a number of factors, among which might be mentioned color, homogeneity in texture, power of resisting decay, ease in quarrying and facilities for transportation. Practically all the granite used in Ontario for monumental purposes is imported. There are undoubtedly valuable varieties of it in the Province, but it is difficult to overcome trade prejudices. An altered granite found in the gold regions of northwestern Ontario and in other parts of the world is sometimes known as protogine, but the name is not used so much as formerly. Granites have in some cases been changed into gneiss through the action of pressure and other agencies.

Specimens of igneous rocks.

Some of the most common accessory minerals of granite are magnetite, apatite, tourmaline and zircon. Cassiterite, or tin-stone, is also found in certain varieties of granite.

Granites are found in bosses and dikes cutting through other rocks, and they are often overlain by sedimentary rocks.

187. Pegmatite. This is a coarse grained rock made up of the same minerals as are found in granite. Quartz and light colored felspar however predominate in this rock, and mica when present is usually light colored. The rock is often a storehouse for rare and valuable minerals, among which may be mentioned tin-stone, tourmaline, corundum and beryl. Graphic granite is a variety in which the gray quartz is so arranged through the white felspar as to present the appearance of characters in the ancient Grecian or Phoenician alphabet.

188. Syenite. Coarse grained; color usually reddish or gray. This rock has much the appearance of granite, and differs from it only in the absence of quartz. Hence a syenite may be called a quartzless granite. While the percentage of silica in granite, on account of the presence of quartz, is high, 65 to 80, making an acid rock, the silica in syenite is in a considerably lower percentage. Hence syenite is said to be a rock of intermediate composition—its percentage of silica lying between that of granite and the basic rocks, or those low in silica. A highly interesting rock known as nepheline syenite is found in the northern part of the county of Hastings, Ontario. In it the rare mineral nepheline plays the part of a felspar.

189. Diorite. Usually a rather coarse grained rock and darker in color than syenite, from which it differs by having plagioclase instead of orthoclase as its felspathic constituent. Typical diorite consists essentially of plagioclase and hornblende.

190. Gabbro. Often very coarse grained; usually dark in color. It contains a lower percentage of silica than diorite, and typical specimens are composed essentially of basic plagioclase and the variety of pyroxene known as diallage. Where hypersthene is present as an essential constituent the rock is known as norite. Anorthosite, a rock related to gabbro, consists essentially of lime-soda felspar. It may be mistaken for crystalline limestone, but is harder. Gabbro often contains much magnetite, and it is believed by some authorities that certain magnetite deposits found associated with this rock are of igneous origin, and have been formed at the same time and out of the same molten mass as the gabbro with which they are associated. A similar theory has been proposed to account for the origin of the nickeliferous pyrrhotite deposits of Sudbury, which are associated with gabbro like rocks.

191. Obsidian. This is a natural glass. It is, in some cases, a volcanic representative of the plutonic granite, as the two rocks agree in chemical composition. Their structural difference, one being a glass and the other a coarsely crystalline granular rock, is to be accounted for by their difference in origin. Granite originated deep down beneath the surface of the earth by the gradual or slow cooling of molten matter. On the other hand, the molten material from which obsidian was formed poured out at the surface of the earth and lost heat so quickly that there was not time for the molecules of the minerals to arrange themselves so as to form grains. The whole mass became solid in a comparatively short time. Rhyolite is like granite in chemical composition, but is more or less glassy. Sometimes it is composed of crystals of orthoclase and granules of quartz set in a glassy groundmass.

Rhyolite.

192. Pumice. This rock is a porous or vesicular obsidian. Pitchstone, which is resinous in appearance, may be looked on as a devitrified obsidian. The name felsite is sometimes given to a devitrified glassy rock, fine grained and compact in structure, and consisting of orthoclase intimately mixed with some quartz. It has a flint-like fracture, and sometimes is very dull or stony in appearance. The term felsite is however, like the names of some other rocks, so differently used by different writers that its reputation as a rock name is lost.

193. Trachyte. A volcanic rock which corresponds to syenite in chemical composition, light gray in color and presenting a dull appearance. Sometimes looks somewhat like a fine-grained limestone.

194. Andesite. This is the volcanic representative of diorite.

195. Basalt. Corresponds in chemical and mineralogical composition to gabbro, and is one of its volcanic representatives. It is a dark, heavy, close-grained rock, and is often known under the name of trap. It often possesses a columnar structure, and frequently contains cavities through it which are filled with agates, zeolites or other minerals. Basalt is a characteristic rock on the north shore of lake Superior.

196. Columnar Trap.

197. Diabase. This is another volcanic representative of gabbro. It differs from basalt in structure. Typically it consists of the two essential minerals, plagioclase and augite, but olivine may also be present, when the rock is known as olivine diabase. Diabase tends to weather at the surface of the ground into spheroidal or ball-like masses. When examined in thin sections or slices under the microscope the plagioclase is seen to be in lath-like strips which are set into the augite. On a weathered surface of the rock, in hand specimens, the plagioclase laths may be seen as very fine short white lines, a characteristic by which the rock may be distinguished. Of course if the surface examined is much rusted or decomposed the lines do not come out. Various accessory minerals are found in the rock. It forms dikes and masses in different parts of Ontario, notably in the vicinity of Sudbury.

AQUEOUS ROCKS.

198. Conglomerate. This is composed of rounded fragments of various rocks or minerals cemented together by calcium carbonate, iron oxide or other material. A mass of it may be called a solidified gravel bed. Samples of Aqueous rocks.

199-200. Sandstone. Composed typically of quartz grains of various colors cemented together, but the rock may be more or less impure from the presence of other minerals. It possesses a bedded or stratified structure.

201. Shale. This rock is composed typically of clay. It is very fine-grained and occurs in very thin layers.

202. Clay. The character and uses of this material are well known.

203. Kaolin. Ordinary clay is an impure form of this substance.

204. Limestone. Rocks of this class differ much in color, grain and composition. Typically they are composed of the mineral calcite, together with more or less dolomite. They are formed through the accumulation of

shells and other calcareous structures of various fresh water and marine organisms, such as mollusca and corals. Many limestones contain fossils, thus showing their organic origin, but usually the calcareous material is more or less crushed or broken up. Some limestones have originated entirely through the deposition of calcium carbonate from aqueous solutions.

205. Lithographic Stone (Limestone).

206. Hydraulic Limestone.

207. Dolomitic Limestone.

208. Calcareous Tufa. In this rock the calcium carbonate of which it is composed has been deposited from solution. The rock is more or less porous in appeorance.

209. Shell Marl. This rock is made up almost entirely of the calcareous shells of small organisms.

210. Chalk. This has a similar origin to shell marl but is usually purer and more compact.

211. Tripolite. Is formed by the accumulation of the shells of minute organisms known as diatoms. It is composed of silica and is used as a material for polishing.

METAMORPHIC ROCKS, ETC.

Samples of Metamorphic rocks.

212-213. Gneiss. Is similar in mineralogical composition to granite, but is distinguished from this massive rock by having its minerals arranged in a more or less layer-like form.

214. Mica Schist. Composed essentially of the minerals quartz and mica. It splits readily into thin layers or foliæ.

215. Hornblende Schist. Has a more massive appearance than mica schist, and its chief mineral is hornblende.

216. Quartzite. Is a hardened or metamorphosed sandstone.

217. Quartzite (flexible) or Itacolumite.

218. Slate or Argillite. The term slate is used somewhat loosely, but should be restricted to a rock which is a metamorphosed shale (clay). It splits or cleaves in directions independent of the original bedding.

219. Crystalline Limestone. This is similar in composition to ordinary limestone, but is crystalline in appearance. Some varieties used in the arts are known as marble.

220. Calc-schist. Is a variety of crystalline limestone.

221. Vein and Country Rock. This specimen is taken from the contact of the vein and country rock at the Deloro gold mine, Marmora, Ont.

222. Thin Section of Rock. This specimen shows a thin section or slice of diabase prepared for examination under the microscope.

223. Photograph. Shows the appearance which a thin section of diabase presents under the microscope. Photographs taken of objects through the microscope are known as photomicrographs.

SECTION IX.

SOME NOTES ON THE MILLING OF GOLD ORES.

By John E. Hardman, S.B., M.E., of Montreal.

To the mine owner whose property has passed from the stage of a prospect into that of a partially developed mine, the subject of the proper treatment of his ore is perhaps the most immediate if not the most important one he has to consider.

The rapidly accumulating evidence which western Ontario offers of possessing large areas of free-milling, or partially free-milling gold ores, may make these notes I have to offer more or less valuable to some of you who are the fortunate possessors of lands carrying such ores.

The old distinction between free-milling and refractory gold ores is getting less and less sharply defined each year, owing to the progress made by metallurgists in their treatment. Free-milling and refractory ores.

Broadly speaking, a gold ore may be termed free-milling if the major part of its gold value can be extracted by amalgamation with mercury; partially free-milling if a considerable fraction (but less than one-half) of its gold can be extracted by crushing and amalgamation; and refractory when no part, or a very inconsiderable fraction, of its gold contents are thus recoverable.

PROCESSES FOR TREATING GOLD ORES

For the treatment of free or partially free-milling ores, the recognized steps are: Fine crushing by stamps, amalgamation within the mortar and on the plates by mercury, and the concentration of the metallic sulphurets in the tailings by means of vanning machines. Three stages of treatment.

Various combinations of these three steps or processes may be used to advantage, depending upon the nature and character of the ore, the gangue, and the manner in which the bulk of the free gold is contained in the vein stone.

Various supplementary processes also, such as chlorination for treatment of the metallic sulphurets, and cyaniding for treatment of tailings with or without previous concentration, are employed by the competent metallurgist to extract the highest economical percentage of the gold contained in the ore.

The various details of precipitating the gold from its solution, and the use of combined cyanides (such as the bromo-cyanide process) are all details of the main steps in the consecutive treatment of a gold-bearing rock.

It is of importance, then, that a proper selection of a method or process should be made at the outset, before incurring any heavy expense for a reduction plant, since failure to recognize and adopt the proper process at the start may entail double expense on the owner or company through the pulling down and re-building of his mill, or, what is worse, and perhaps more frequent, cause the abandonment of the enterprise through failure to extract a remunerative amount of gold from the ore as treated.

[1] A paper read at the annual meeting of the Ontario Mining Institute, April, 1897.

It will manifestly be impossible to attempt to give you a full orc omplete account of all the varieties of conditions and of ores met with in practice; the limits of this paper will only permit me to note the outlines of the most prominent conditions.

In selecting the approximately correct process for milling a gold ore, comparatively simple tests at the beginning will show you whether your rock is free-milling, partially free, or refractory.

Testing ores for selecting the most suitable treatment.

A weighed average sample of your stone, about four pounds in weight, should be finely pulverized, and all of it passed through a 30- or 40-mesh sieve. Note whether any of the gold contained is large enough to remain on the sieve; if so, separate it and add it to what you obtain afterwards. All the gold thus obtained should be weighed.

Take the full four pounds, put them in an iron mortar with water sufficient to make the whole into a paste, and add from a teaspoonful to a dessert-spoonful of clean mercury, then grind the whole mass vigorously together for half an hour, when a small lump of potash cyanide may be added, not bigger than a 32-bullet, and the grinding continued for ten or fifteen minutes more. After this pan off your pulp, taking not more than one pound at a time and thinning it when in the pan with plenty of water.

The resulting quicksilver and amalgam obtained is then strained through a bit of soft buckskin and retorted, and this gold added to what was obtained on the screen.

Save your tailings from panning and have them assayed. If you find that you have extracted the greater part of the gold by panning, the usual stamping and amalgamation process is the one indicated, and the value of your tails when concentrated to clean sulphurets will indicate to you whether it is advisable to add vanners to your mill or not.

Should the test show that the larger value of the ore is not in free or metallic gold, but is contained in the sulphurets and tailings, then a sufficiently large sample (not less than one ton) should be sent to a testing laboratory for determination of the proper method, or the services of a competent metallurgist should be engaged to examine and test your ore.

In cases where the larger value of the ore is contained in the metallic sulphurets which occur in the vein, it has frequently been found advisable to crush such ore coarsely by means of rolls and concentrate the sulphurets first, subsequently grinding the tails from concentration, either by pans or light stamps, and amalgamating them with mercury, following such amalgamation again by vanners. Care must be exercised however in considering this method and in the further treatment of the concentrates, that the gold contained is not coarse, or nuggety, else may occur the same disaster that many of you may know more of than I do. I refer to Deloro, where the tails from the roasted and chlorinated mispickel gave good returns of free coarse gold by panning, and even by sluicing.

I can only say enough on selection of process to give you an idea of its importance, in order to have the first step made rightly, and to advise, in all cases, obtaining expert advice.

From what has been published, and from what I have seen of the ores

of your great gold field, the usual method of stamping, amalgamation and concentration, automatically and in regular order, will be the prevailing process employed. A few notes therefore on some of the machinery and its operation may be of value.

PLANT FOR FREE-MILLING ORES.

The design of the plant is entirely dependent upon local topography and circumstances. The idea governing such design should be to make the whole as automatic as possible, avoiding labor of handling, which is always the chief factor of costs.

The governing idea in location of plant.

The item of foundations requires attention. The foundations of your mortars should always be of wood placed on end. Such wood may be large sticks, dressed and well fitted, or of dressed plank spiked together, as circumstances and costs may determine; but always carry this wooden mortar block to the solid rock, and do not have the length of the mortar blocks less than ten feet. There is a certain resilience or elasticity in wood placed on end which is not fully developed in lengths of less than ten feet.

Foundations for mortars.

The foundations of your mill-engine and concentrators are of nearly equal importance. For the former a solid bed of concrete of the form of a truncated pyramid is advisable; for the latter, well weighted mudsills, braced to ensure stiffness and freedom from racking horizontally, are desirable.

engine and concentrators.

The prime motor of your mill, be it steam engine, water wheel or electric motor, should run steadily without serious variations of load.

The best modern practice is not to put rock breakers on the mill engine, but to locate them at the shaft-house or rock-house, and operate them by independent motors. When both concentrators and rock breakers are run off the mill engine, the variations of speed due to the working of the breaker cause constant attention to adjustments of the vanners, and correspondingly poor work by them and infinite annoyance to the mill man.

Placing the rock breakers

Whether the California knee frame or the Dakota bin frame for the superstructure at the mill is adopted, may depend upon the idiosyncrasies of the designer. The pros and cons are briefly these: Knee frame—Accessibility of line shaft for alignment, ease of oiling and inspection, horizontal driving belt against a vertical one; less stability, more likely to get out of alignment. Bin frame—Greater stability, but the line shaft is in the dark, hard to keep free from grit and dirt, broader trail, less accessible, necessitates tightener pulley, wearing belt quicker.

Superstructure of the mill.

Choice of the wood to be used in the important parts of the frame, like the battery posts, binders, guide binders and braces, must be governed by character of the local timber and by cost. Where cost is not prohibitive, I have preferred of recent years putting in southern pine (long-leaved yellow pine), which never checks nor seasons to cause disturbance.

A question that has frequently been asked of me is whether two 12 by 12 in. posts may be bolted together to make a 12 by 24 in. post. There is not the slightest objection to joining two posts thus, provided you have a competent workman to fit the two surfaces together; the joint must be as perfect as possible, and the two sticks pin-dowelled together as well as thoroughly bolted.

I have used battery posts thus joined for over six years and have never observed the slightest weakness in them nor any objection to their use.

Iron work of the mill.

In coming to the iron work of the mill, let me draw your attention to the use of friction clutch pulleys on the line shaft for driving the cam-shaft pulleys. In many years' use I have found them the most convenient, speedy and desirable device, enabling one to disconnect any battery quickly and without danger. Of the materials from which the wearing parts are made, there is a decided tendency to replace iron by steel in every place possible.

The mortar remains of cast iron, of a tough, but soft character; the cam-shaft of mild steel, running in cast iron boxes, made of a soft graphitic iron, I have found most satisfactory. Cams and tappets are now almost universally made of a hard steel, such as chrome or manganese, and must be ground on wearing surfaces to a true smooth face.

Stems still remain of best wrought iron or of mild steel, and heads or bosses are usually of the same material as the mortar, viz., tough cast iron. As to shoes and dies, I need not specify, for I imagine you all have your preference. I may however add that very few small mills keep their records in such shape as to really know what is the cost of iron per ton of rock melted.

Specifications.

In ordering a new mill, it is of the utmost importance that your specifications should be clear and exact, and that you should know just what duty comes upon each part of the mill and provide for it. If you do not know, get your specifications revised by someone who does.

Adjustment of apron plates.

A device regarding apron plates which is worthy of adoption is one permitting their adjustment to different degrees of inclination. This is particularly valuable when rock from two or more different veins is to be milled; one rock may carry more clay or slate than another, and it is of advantage to be able to adjust the plate for the mortar in which such ore is being milled. For it is surely unnecessary to say that stone from each vein should be milled in its own mortar, and not mixed with other stone. By this means only can one ascertain the relative values of rock from different portions of the vein, and locate approximately the limits of the pay chute.

ON THE METHOD OF RUNNING A MILL.

Practical suggestions on details of milling.

Having such a mill, well designed and well adjusted, there are some few notes as to its daily running which may be of use.

The rock breaker.

As to the rock-breaker, it is good policy to set this to crush to pass a small ring, one inch, if possible; first, because the self-feeder runs with less attention, secondly, because the wear of shoes and dies is more uniform, and thirdly, because your daily capacity per stamp is much increased. Of course the limitation in this respect will have to be governed by the capacity of the breaker you have, but it is good policy always to put in a much larger breaker than the rated capacity of your stamps require.

Water supply for the mortar.

The introduction of the water to your mortar is also an item worth noticing. It should be fed from a tank with constant level, to ensure a uniform quantity per unit of time, and it is advisable to have this tank at a

considerable height above the mortar, say 20 feet. Instead of the old-fashioned faucets, one to each stamp, the better practice is to introduce a ¾ in. pipe with straightaway cock between stems 1 and 2 and 4 and 5, making only two cocks to each five-stamp battery. A device which has been used in Ontario, and also recently in Nova Scotia, is the introduction of upward pointing jets of water from the base of the chuck block, one jet between each die; the advantage claimed being an avoidance of the hardpacking of sulphurets between the dies, and consequent aid to amalgamation.

The matter of the height of the discharge opening above the top of the die is one which is directly dependent upon whether the stamp mill is used only as a crushing machine or as a crushing and amalgamating machine combined, and also in the latter case upon the amount of and manner in which the gold is contained in the ore. For subsequent concentration, when the chief value lies in the sulphurets, a low discharge and coarse screen prevents much of the sliming which is fruitful of loss on the vanner. Discharge from the mortar.

Directly connected with this matter also is the speed and height of drop of the stamps; but the order in which stamps drop, other conditions being equal, governs only the matter of discharge through the screen, and the even distribution of pulp throughout the mortar, so as to prevent banking and give each stamp a uniform quantity of work. Speed and drop of stamps.

The preparation and introduction of mercury into the mortar is an item frequently disregarded, and productive of losses when not properly attendep to. Treatment of mercury.

Mercury as it comes in the flask is too dirty for use in gold amalgamation, and should be purified by retorting at least once. Whenever grease, oil or other fatty matter, or other substances like graphite, some sulphide ores like mispickel, and partially oxidized sulphurets containing sulphates like some galena ores, are churned up in the mortar by the stamps, the mercury which has been fed becomes partially sickened or "floured" as it is called, breaking up into minute gray globules which do not coalesce, and which usually escape the traps and get lost with the tails. This loss usually entails a loss of gold also. Naturally the cure depends upon the cause. If due to grease, the addition of small amounts of slaked lime, thrown into the hopper of the self-feeder from time to time, will usually cut the grease or saponify it and remedy the trouble; if however too much in quantity, the addition of a stronger alkali is required. Screened wood ashes are used with good results in many places. If due to mispickel or the presence of much graphite, the addition of common salt has often been found effective; but some cases do not yield to such treatment. Doctoring "floured" mercury, and

Mercury should always be purified by retorting under a cover of quicklime, putting the retorted mercury subsequently into a large porcelain-lined vessel and covering it with a dilute solution of nitric acid in the proportion of one of acid to four or five of water. The mercury for the mortar and plates should be dipped out of the vessel and washed free from acid before using.

Another difficulty met with in the use of coppers which have not been silver-plated is the verdigris or green stain often forming in spots or streaks on the plates. This stain is due simply to the formation of oxy-salts of sick apron plates.

copper where the metal has not been thoroughly amalgamated with quicksilver. With care and attention these spots can be permanently removed. Having thoroughly cleaned the spot to be attacked, dry it and scrape it with a blunt-edged chisel or other edged tool until the copper shows bright and clean ; then thoroughly rub into it mercury with a piece of canvas or chamois moistened with cyanide of potassium solution ; when well silvered, paint over the spot with a very fine gold amalgam, and let the amalgam set for 24 hours before using the plate again. To prepare this very fine gold amalgam, it has been my habit to acquire a bit of old copper plate well coated with gold amalgam, and by "sweating" this plate carefully over an ordinary kerosene lamp to scrape off the adhering amalgam, which is then put into a Wedgewood mortar with a little quicksilver and well ground together Rapidly pouring off the mercury, after skimming, leaves the coarser particles of amalgam behind, while the portion poured off if allowed to stand 24 hours may be carefully decanted from the fine amalgam which has settled to the bottom, and which will be found to be of the consistency of cream, and admirably adapted for doctoring sick apron plates. It is advisable to always carry a small stock of this cream amalgam on hand.

Cautionary measures.

I may also caution you against the lavish use of cyanide of potassium, which is detrimental to the plate rather than beneficial, if used in excess or too frequently. Again, if you would have clean plates, avoid the use of pit water, which usually is acid and carries too much of dissolved sulphates and other minerals to give clean amalgamation.

Percentages of amalgam on the mortar and outside plates.

The percentages of amalgam recovered in the mortar and on the outside plates are very various, differing with the design of the mortar and its appurtenances, with the regulation of speed and height of discharge, and with the character of the ore. A free-milling ore treated in a gravity-stamp battery of suitable design can be milled so as to recover fully 90 per cent. behind the screen, i.e., within the mortar. Many instances have been recorded by myself where the saving in the mortar has reached as high as 95 to 96 per cent. of the whole amount recovered.

The few cases in which a steam stamp has been used on free-milling ores (whether of the portable type like the Gates or Tremaine, or the copper-type, as at the Homestake), seem to show that saving in the mortar is impracticable, due doubtless to the heavy churning and swash of the pulp in the mortar. In several cases this has been so great as to scour any inside plate used. I am however inclined to believe that this detriment to the small steam stamp can be removed by a simple change in the pattern of the mortar.

The main factors upon which the saving of amalgam within the mortar depend are :

1. The shape of the inside of the mortar.
2. The height of the discharge.
3. The character of the screen.
4. The height of the drop.
5. The shape and location of the inside plates used.

It would prolong this paper beyond the limits allowed to discuss the influence of each of these factors upon the result, or to touch upon many other minor points of importance, which the skilled amalgamator usually regards as secrets of his trade.

A word for the skilled amalgamator.

And let me say a good word for the real amalgamator, the honest, patient, hard-working, watchful man who is continually studying his ore and his mill, and who takes as great delight in saving an extra half-penny weight from his tails as does his employer. For the quack, who knows it all, who has some "secret" device or some combination of chemicals that will save "105" per cent, beware of him, and get him to leave your camp as quickly as his health permits.

I regret exceedingly that the limits of time prevent me from giving you many more items gathered during a somewhat extended period of thirteen years, which might perhaps have been of interest. I shall hope in the near future to be permitted by your kindness to add perhaps to what I have said here, and perhaps also with the then added experience or personal acquaintance with parts of your great gold field of western Ontario.

SEVENTH REPORT OF

THE INSPECTOR OF MINES.

REPORT OF THE INSPECTOR.

To the Director of the Bureau of Mines:

Sir,—I have the honor herewith to transmit to you my seventh annual Report on the Mines for the Province of Ontario, being for the year 1896.

Work covered by the Report.

The Report does not cover all the mining properties, as your visit to the eastern part of the Province relieved me from going over that part of the field, while Dr. Coleman, the Geologist and Mineralogist of the Bureau, in his western tour during the summer inspected some of the mines lying within his immediate reach, which were at considerable distance from the railway and not easy of access.

Indications of progress in the mining industry

While some of the mines have remained idle as in former years, a large number of new properties have been opened, and although on most of them but limited work has been done, several have been more extensively developed, giving fair indications that as work is continued they may prove valuable producing mines. Steady progress has been made in the older mines worked, and the outlook at the close of the year, especially for gold, is more encouraging than at any former period in the history of the mining industry of the Province. Few fields present more favorable opportunity for carrying on mining operations than Ontario. The various minerals stretch over a distance of a thousand miles from east to west and a hundred or more from north to south, and are found along the public thoroughfares of railway and watercourses or near thereto, with no insuperable mountainous barriers to prevent ready access to them. Timber for building and cheap fuel with water supplies are abundant, and the climate is one favorable for mining work. The most appropriate kinds of machinery both for mining and milling the ores (the gold chiefly free milling) can easily be obtained without extravagant cost, while labor is abundant and cheap.

Government aid in development of mineral resources.

The Ontario Government has not been indifferent in affording timely and liberal assistance in the extension of the mining interests of the Province. Mining lands have been placed upon the market on easy terms, and the Bureau of Mines established, through which full information can readily be obtained in acquiring possession by title or lease with little delay or cost. Public roads have been opened through mining districts, and large expenditures made to improve and keep them in repair. Applications for charters are being made for the construction of needful telegraph lines and railways to reach some of the more remote mining localities, and provision is made to improve navigation in the more dangerous rapids in Rainy river so that the steamers plying between Rat Portage and Fort Frances can make safe and quick trips. Should the improvement extend to placing locks at Fort Frances for the passage of the boats with unbroken cargoes to the upper waters of the

river, and on to the Seine river gold field now being opened up, it would be regarded as a valuable boon to the whole of that promising region where hundreds of locations have been taken up and development work done on many of them, while a 20-stamp mill has just started up and another of equal capacity may be constructed during the present year. The diamond drill purchased by the Government and operated at only part of the cost of working to the owners whose property is being prospected, as well a liberal bonus granted on pig iron the product of iron ores mined in the Province, are amongst some of the methods adopted by the Government to aid in developing the mineral resources of the Province. The yearly visits of Dr. Coleman of the Bureau to some of the new and inviting fields have been the means of giving intelligent directions to prospectors in search of the precious metals. The popular and practical lectures delivered by Mr. Hamilton Merritt, M. E., in several mining districts during the past summer have been highly appreciated by a large number of mining men who had the opportunity of attending them. The providing of small test mills at both the School of Practical Science in Toronto and at the School in Kingston affords to mine owners the special advantage of having their ores tested by mill runs before constructing mills on their own properties without the assurance that the expenditure is well directed.

Capitalists attracted to the country.

The attention of capitalists in Canada, the United States, Great Britain and other countries has been directed to the gold mining districts of western Ontario, and from investments already made it is fair to infer that a much larger amount of capital will be supplied for developing the mines during the present year. Under the existing mining craze through wildcat schemes and fake companies no doubt there will be much misdirected and wasted capital, but to the legitimate and prudent investor openings are presented which can scarcely fail to prove satisfactory.

It is noteworthy that most of the larger worked properties are in good condition as regards the health and safety of the workmen.

I have the honor to be yours very truly,

A. SLAGHT.

Waterford, February 18, 1897.

GOLD MINES.

Sultana Mine.

On July 3rd I went out to the Sultana (the princess of Ontario gold mines) in a little tug of 4 h.p. in company with Mr. M. T. Hunter, the manager of the mine, who came over to Rat Portage on business. The afternoon and part of the day following was occupied in examining the mine, going through the mill and over the outside works.

Chlorination plant in process of construction.

At this date there was being laid the foundation for the erection of the chlorination plant at which a number of masons and builders were employed. The large quantity of fully 300 tons of concentrates had accumulated and was ready for treatment, the value of which was estimated at $40 per ton.

Mr. Albert Johnson, foreman of the mine, accompanied me through the mine, and Mr. James Gale, mill foreman, courteously explained every part of the process in reducing the ore as we went through the mill. Work in the mine at this date was being principally done in third and fourth levels.

Work in the mine.

The shaft, 8 by 18 feet, had reached a total depth of 256 feet, extending down 15 feet below the floor of the fourth level.

Level 1 had been run in north of the shaft 82 feet, with a stope of 50 feet in length, 6 feet in width, and 30 feet raise. South of the shaft it had been driven in 110 feet with stope 35 feet in length, 20 feet in width and raise of 30 feet.

Shaft No. 2 is 40 feet east of No. 1, and was sunk 60 feet and tunnelled through to the south drift in No. 1. It is used for ventilation to the mine and for going in and out if required.

Level 2 is driven in north of the shaft 67 feet with a stope at the back end, having a width 5 feet and raise of 50 feet and timbered over. South of the shaft it has been run in 75 feet with a raise to level 1 and timbered over. The drift is extended beyond the upraise 40 feet, at which point a crosscut is run in east 25 feet and stoping made 20 by 40 feet with 25 feet raise at 72 feet from the shaft. A winze has been sunk to level 3.

Level 3 has been run in north of the shaft 15 feet and south of the shaft 82 feet with a stope at the back end, having a width 30 feet and raise of 45 feet, leaving a roof of 15 feet thickness. Ten feet from the shaft a sump 6 by 20 feet and 10 feet deep to receive the drainage from the mine is made and supplied with a pump to lift the water to the surface.

Level 4 is 75 feet below level 3 and has been run in north of the shaft 12 feet. South of the shaft it has been driven 52 feet, at which place work was being done and a large quantity of excellent ore taken out.

The mine is kept in a very neat and safe condition. All approaches to the shaft in the several levels are fenced with iron guards and good trap doors for covering placed over the entrance to the shaft in each level. The ladders are conveniently arranged with easy angle and short rests, and well cased off from the skipway of the shaft. Around all outside openings guards are placed and notices of danger posted up.

Safe condition of the mine.

Apparently due precaution is taken to provide against accident, and yet two which proved fatal occurred during the year. The night foreman, Axel Carlson, unmarried, 32 years of age, was killed on 21st of April by falling from the ladder below the third level. The accident was not witnessed by anyone. The other case was that of Charles Westman, about 30 years of age, who was killed on 5th of June by falling in the shaft from the first level. The accident was witnessed by eight men. At the request of the Director a special inquiry was made in this latter case when I visited the mine. From all evidence obtained, some from parties present when the accident occurred, as well as others, it would appear that the death was purely accidental and blame could be attributed to no one but the unfortunate man himself.

Accidents during the year.

About 60 workmen were employed at the time of my visit, including miners, mill men, masons and builders engaged on the chlorination building. The usual force is about 45. The large body of ore easy of access now opened

Force of workmen employed.

up in the mine requires only a limited number of miners to keep the 10 stamp mill constantly running, treating about 25 tons daily. The weekly product was about $3,000.

Process of chlorination.

At the date of my visit the chlorination plant, which was being put up under the superintendence of Mr. O. Garnett Rothwell, was expected to be ready for use in about a month. The process for treating the concentrates may be described as follows:

The concentrates are roasted in a reverberatory furnace 8 feet wide, 60 feet long; they are then trammed to a hopper over the chlorination barrel. The chlorination barrel has a capacity of $1\frac{1}{2}$ tons per charge. The requisite amount of water, sulphuric acid, chloride of lime and roasted concentrates are put into the barrel and it is allowed to revolve for a certain length of time, at the end of which the barrel is stopped and the ore leached till it shows no gold reaction. The solution is then treated with sulphur dioxide and sulphuretted hydrogen, precipitating the gold as a sulphide, which is collected in a filter press, dried, roasted, fluxed, melted and run into a mould.

Extent of workings in the mine in February.

In answer to an inquiry made about the extent of work done in the mine Mr. M. T. Hunter, the manager, writes under date of 5th February, enclosing measurements of the work in the mine taken by Mr. Johnson, the foreman.

"In No. 1 shaft it is 60 feet to level 1, 60 feet to level 2, 60 feet to level 3, 75 feet to level 4, and 75 feet to level 5, making the total depth of the shaft 330 feet. At the first level in shaft 1 a drift runs north 80 feet with a stope 50 feet in length and 6 feet in width and raise of 30 feet.

"The south drift in the same level extends 110 feet with stope 35 feet in length, 20 feet in width and 30 feet raise, and connects with shaft No. 2

"Shaft 2 at 40 feet east of 1 is sunk 60 feet and tunnelled through to the south drift in shaft 1. It is used for ventilation, and can also be used for ingress and egress when required.

"In level 2 a drift has been run north 67 feet with a stope 5 feet in width and raise of 50 feet, timbered over. South of the shaft it is 75 feet with a raise to level 1, and timbered over. This drift extends 40 feet further south with a cross-cut east 25 feet. The stope is 20 by 40 feet and a raise of 25 feet. A winze is sunk to level 3.

"On level 3 a drift has been run in north 15 feet; also a drift has been run south 85 feet, with a stope at the end having a width of 30 feet and raise of 45 feet, leaving a roof of 15 feet. At 10 feet from the shaft a water sump has been made 6 by 20 by 10 feet, with pump.

"In level 4 a drift runs north 62 feet, 4 by 6 feet, and a drift runs south 80 feet with winze connection with level 3. The width of stope at the end is 35 feet with a raise of 40 feet.

"In level 5 the drift has been run south a distance of 40 feet to connect with a winze sunk from level 4; 10 feet from the shaft south a water sump has been sunk 6 by 20 by 10 feet, and from this water is pumped to the sump in level 3, and thence to the surface. All ladderways and timbering are complete to the fifth level.

"The work of sinking in the shaft below level 5 is about to be resumed. The daily quantity of ore mined and milled is 25 tons ; there is an equal amount of waste rock hoisted which is dumped into the lake. The number of men on the pay roll is 44."

Mr. Hunter adds to his note : "The mine is so far advanced that it becomes necessary to increase the stamping power. Mr. Caldwell is now in the east arranging for a 30-stamp mill. As it is, we can mine far more ore than we know what to do with. One drill machine suffices to keep the mill going, the other two machines being free to do development work. It is the intention to commence the building of the new mill as soon as the lake is open for navigation." Arrangements in progress for a 30-stamp mill.

On July 15th I visited the Gold Hill, Black Jack and Golden Gate mines owned by the Dominion Gold Mining and Reduction Company, Limited. For location and description of property see Director's Report in last report of the Bureau of Mines, pp. 174, 175 and 176. Work on the Gold Hill property had been suspended since December 1st last It is under the care of Mr William James, who resides on it and has charge of the Golden Gate mine adjoining. I was informed by Mr. Ahn that he is prepared to expend a large amount in developing the property very shortly. *Gold Hill, Black Jack and Golden Gate Mines*

Three shafts have been sunk on the Pebble vein. No. 1 shaft has been sunk to a depth of 60 feet, being 46 feet since last entry. The shaft is filled with water. No. 2 shaft on the western ridge has been sunk to a depth of 80 feet, being 14 additional since last entry. A shaft house has been erected. No. 3 shaft, distant 220 yards from No 1, has been sunk to a depth of 22 feet ; no additional sinking since last entry.

The mill has been refitted and put in good running order. A test run of 100 tons of ore was made and proved entirely satisfactory. The general manager, Mr. R. H. Ahn, in a letter of the 6th inst., says : "About 50 feet of sinking has been done on this property since you saw it. New hoisitng and pumping plants have been erected."

No work has been done or change made on the Black Jack property since last entry. Of additional work since my visit, (July 15th,) Mr Ahn writes : "About 30 feet of sinking has been done on this property. A steam hoisting plant and pump have been erected."

On the southwest corner of the Golden Gate location work has been commenced by opening a pit of about 100 feet in length, 10 in width, and of shallow depth, from which 20 tons of ore were taken and treated in the mill on the Gold Hill property, yielding I was informed over $30 per ton. About 200 yards south of the open pit a shaft 7 by 12 feet has been sunk to a depth of 36 feet and timbered down 8 feet to solid rock. At 12 feet from the surface an open cut has been made from the shaft south to the slope of the hill. The vein is perpendicular and 4 feet wide at the bottom of the shaft, and runs east and west. A considerable quantity of apparently rich ore was on the dump. A hundred tons of ore from the workings have been treated in the Gold Hill mill, yielding a product of $1,500. Two large veins are on this location, one 40 feet and the other 60 feet in width. The latter runs southeast and northwest. The

former runs due north and south and has been traced half a mile and opened by stripping in seven places. The 60-foot vein joins the 40-foot vein at the granite.

The Dominion Gold Mining and Reduction Company owns the Gold Hill and Black Jack locations, and the adjoining property, Golden Slipper, including in all 1,200 acres. Eight men were employed on the Golden Gate property, and Mr. James has charge of the work. The buildings at Gold Hill are being used for the accommodation of the workmen.

I made all necessary entries in the Inspector's book, which was left with Mr. R. H. Ahn, the general manager, with copies of the Mines Act, one to be given to the foreman of the work.

Neglect to carry out instructions.

It is a matter of regret that the necessary instructions given by the Director in his visit of September last have not been carried out by fencing or otherwise protecting the outside unused shafts and pits as requested by the regulations of the Mines Act. I called the attention of the foreman at the locations and also of the general manager to this remissness, and directed their special attention to the several clauses in the Act relating to the requirements to avoid accident. I directed that this part of the regulations should be forthwith complied with.

Nonesuch, Three Ladies and Three Friends Mines.

Mr. Oliver Daunais of Rat Portage gave me the following description of properties which he owns, but which are now lying idle:

The Nonesuch is situated on Skunk island at the bottom of Echo bay, 25 miles via water and 16 by winter road from Rat Portage. During last summer 6 to 8 men were employed for a length of time in opening up the property by sinking a shaft 70 feet. At 26 feet down a drift was run in westerly 18 feet, and discontinued as it was not safe on approaching nearer the water of the lake. At 60 feet from the surface, a crosscut was made showing the width of the vein to be 45 feet, with granite foot wall; the hanging wall is schistose slate. From 500 to 600 tons of ore were mined, assays varying from $6 to $60 per ton. Two men are kept at the mine bailing out water and making improvements.

Another location of between 50 and 60 acres is on the mainland bordering Clearwater bay, and is known as the Three Ladies mine. It is 10 miles nearer to Rat Portage than the Nonesuch. Two veins have been opened and traced for 600 feet, running parallel with each other north and south. The smaller one is stated to be from 20 inches to 3 feet in width, on which two shafts have been sunk 48 feet and 57 feet respectively. The other vein is 150 feet distant from the former; a shaft has been sunk 30 feet, showing the width of the vein to be 6 feet. The property was bought for $7,500, to which has been added the expense of development work. Although work has been suspended for the past four years, Mr. Daunais regards the property as one of great value.

The Three Friends mine is located on the same bay, five miles distant from the Three Ladies mine, on which a rich deposit of ore has been discovered; a shaft has been sunk 45 feet.

On Saturday July 11th, in company with Lieutenant General Wilkinson, the managing director, Mr. R Huntley, the chief engineer, and others, I left Rat Portage to visit the Regina mine. In the afternoon we boarded the small steam yacht Squaw, which the General had recently purchased and completely refitted for the company's service. She was built at Ottawa in 1891, is 60 feet long and 13 feet beam over all. She can carry 16 tons of cargo and steam at from 10 to 12 miles an hour, is fitted with a pilot house in front of the engine, and has a large hatchway in the bow, giving easy access to the forward hold. Abaft the engine is a commodious cabin, above which a spar deck will be constructed. With this boat a double journey to Rat Portage and back to the mine can easily be completed in one day, the distance being 45 miles by water. The cost of the craft was about $4,000. This was her first trip made in the Lake of the Woods, and after we had enjoyed a beautiful run of two or three hours a blinding tornado of wind, rain and hail of over an hour's duration swept down upon us, causing the Squaw to rock and roll by times as though drunken; but she bravely outrode the fearful raging storm, showing no symptoms of weakness nor signs of foundering. The verdict of the passengers, of whom there were several besides the crew, was decidedly given that she is seaworthy. With the clearing up of the sky the remainder of the run was made rapidly, arriving at the dock of the mine late in the evening. The shrill whistle of the little steamer had given the signal of our coming, and several small boats, filled with the workmen, had pulled out in the bay to give to the General a hearty welcome on his return, after an absence of several days. The storm with unabated fury had swept up the lake and over the point of mainland jutting out into Regina bay on which the mine is situated, levelling many of the trees which had been left standing, unroofing some of the dwellings, breaking loose the dock and causing general confusion for a time in the camp, but no serious accidents occurred.

Regina Mine.

The Company's steam yacht Squaw.

I was provided with comfortable lodgings in the residence of Mr. Robert Huntley, chief engineer, to whose genial wife and daughter I am especially indebted for the enjoyment in their home of the quiet Sabbath rest. It may be stated in honor of General Wilkinson that besides his repute for kindness and integrity he conducts a religious service every Lord's day in the dining-room for the benefit of the workmen, to which all are welcome.

Monday and part of Tuesday were occupied in examining the mine, the mill and outside work, and on Tuesday afternoon, in company with the general manager, Captain Jones and two or three builders who had completed their work, we returned to Rat Portage.

Work has steadily advanced at the mine since the visit of the Director last year, whose elaborate description of the property is given in the fifth Report of the Bureau of Mines, p. 180.

The official staff is composed of managing director, General Wilkinson, milling superintendent and assayer, John Leechman, John Jones, captain of the mine, and Mr. Robert Huntley, chief engineer.

Progress of operations since former inspection.

The shaft on No. 3 vein, known as the main shaft, has been sunk to the total depth of 144 feet, being additional sinking since last entry in the Inspector's book of 94 feet. At 60 feet from surface a level has been run in south 133 feet, with nearly all the ore stoped out for a distance of 70 feet from entrance and with a raise to the tunnel above. Stoping has been commenced near the end of the level. At 100 feet from the shaft a winze has been sunk to connect with level 2; also a level north of the shaft has been run in 27 feet. Work was suspended as further progress would interfere with the foundation of the mill. At a depth of 48 feet from level 1, and 108 feet from the surface, a level has extended south of the shaft 97 feet, and is now within 3 feet of connection with the winze from level 1. A level north of the shaft has been run in 63 feet and discontinued, as it is considered unsafe to run under the lake at this shallow depth. A stope in this level is being made at a distance of 15 feet from the shaft. The main shaft has reached a depth of 36 feet below the floor of level 2, and sinking is being continued.

The ladder or man way of the shaft has been securely divided from the skip-way down to near the second level; this open part of the shaft must also be cased off from the ladder-way to insure safety to the workmen. The ladders are firmly placed at convenient angles with substantial rests or platforms at near distances. Guards were placed at all the approaches to the shaft and coverings to the entrances, excepting the part yet to be divided; otherwise the shaft was in a neat and safe condition.

The tunnel starting at the mouth of the shaft has been driven in 209 feet, being additional since the last entry of 132 feet, and the work is being continued. The vein at the place of working in the tunnel measures 12 inches in width. The winze at 70 feet from the entrance has been sunk through to level 1, making 50 feet additional sinking since last entry. At a short distance from the entrance a pillar has been left standing for support; the ore has been stoped out to near the surface and the tunnel timbered over. Elevation from floor of tunnel to surface about 50 to 60 feet.

At a distance of 400 feet from the main shaft on No. 3 vein an air shaft 6 by 7 feet is being sunk to eventually connect with the tunnel. The depth at this date is 30 feet and work is progressing. A shaft known as Camp shaft has been sunk 19 feet on No. 1 vein and discontinued in order that the labor might be employed on a more promising location on the West vein. About a dozen additional quartz veins have been discovered on the property running parallel to No. 3 vein. All that have been assayed show gold and several in paying quantities; one assay of ore from a vein supposed to be a continuation of the West vein showed one ounce. The West vein is 20 feet in width and runs parallel with the other vein. The outcropping has been traced 200 yards, and a number of stringers or veins of pure quartz are embraced in it. About the middle of this vein a shaft of 6 by 10 feet has been sunk 17 feet. This shaft includes two of the small pure quartz veins and at the depth of the shaft they have consolidated into one vein of 36 inches in width showing per assays $1\frac{1}{2}$ to 22 pennyweight of gold. The shaft is about 300 yards west of the mill and 40 feet above it. It is proposed to construct

a down grade tramway over which the ore can be carried into the top of the mill.

An additional boiler, 80 h. p., has been put in place and will be ready for use during the present week; also a three drill Sargent-Ingersoll air compressor and air holder have been added and will be operated within a few days. Piping for the compressed air had been put in place in the tunnel and all the levels and three or four air drills will be employed constantly in the mine. A new three-quarter inch pliable steel cable has been supplied for the hoist. A Northey pump is placed in the second level of the main shaft, and takes from the sump underneath all the drainage from the mine. A Cameron sinking pump has been provided, but not yet brought into use. Machinery

The mill has been running only at intervals. A new amalgamating table has been added for cleaning up the battery sands, and a separator has been placed at the mercury trap. All steam pipes in the mill have been supplied with asbestos coverings. Two Northey pumps are used in the mill, one to supply water for the reservoir, the other to feed the boilers. All exposed parts of the machinery in both mine and mill are protected by guards excepting the fly wheels on the air compressor, and these must be guarded when started for work. Safety valves, water guages and dials are in place on the boilers.

The mill has been running at intervals since September 5th, 1895, making a total of 2,897 hours, and treating during the time 2,787 tons of ore, giving a return of 943 ounces of gold with a heavy loss in the tailings.

The hoist shaft and dressing room which were destroyed by fire during last winter have been rebuilt on a larger scale.

Houses have been erected for the chief engineer and the captain of the mine, together with several smaller dwellings for the workmen. The large sleeping camp has been furnished and a new office built, also an assay office and a larger and commodious blacksmith shop.

The force employed consists of an office clerk, 28 miners, 2 muckers, 1 timber man, 2 landers, 3 engineers, 8 mill men, 22 general work, 5 carpenters, 2 blacksmiths, 1 mason, 1 charcoal burner, 1 in store, 2 cooks, 2 cookees and 3 boatmen, making a total of 84. This includes men who were employed during active construction work, and the number will soon be reduced.

Accompanying the Inspector's book which was given to the managing director were copies of the Mines Act for the captain of the mine and mill foreman, with the special request to carefully examine the mining regulations therein contained. Notices were also posted up.

In a letter under date of January 14th last the manager, Mr. John Leechman, states that since my visit to the mine in July the main shaft has been sunk 89 feet, the tunnel driven 7 feet, the second level south 200 feet, the third level south 116 feet, the third level north 107 feet, the West shaft has been sunk 55 feet and the first level north driven 14 feet. The quantity of ore mined in the interval was 3,239 tons. " No changes have been made in the mill, which has been running steadily since your visit," Mr. Leechman adds The number of laborers (including miners) employed underground is 30, and at the mill 7, including mill men, engineers and foremen. Progress made to January.

Mikado Mine. Since the visit of Dr. Coleman to the Mikado last summer it has attracted special notice for the extent as well as the richness of the ore. He then made note of it in Bulletin No. 1 as follows:

"Perhaps the most interesting mining development of the year is to be found on the western Shoal lake, 35 miles from Rat Portage and about 10 miles east of the boundary of Manitoba. The Mikado mine, found by an Indian a year ago, has been purchased for $25,000 by a London company under the chairmanship of Col. W. T. Engledue, and has been worked sufficiently to show that the ore is very rich, though not enough sinking has been done to prove the extent of the deposit. The quartz contains a variety of sulphides, including a sulphide of bismuth new to the Lake of the Woods region, and a considerable part of the gold is carried by these refractory minerals, but probably two-thirds of the gold contains ore free milling, the gold occurring in thin plates rather than nuggets. The ore treated is the richest found in large quantities in Ontario, and the ore now on the dump, after only a few months work by a small force, contains value sufficient to pay for the mine and a simple equipment."

Col. Engledue's report to his company. The following is the official report made by the chairman, Colonel Engledue, at the ordinary general meeting of the South African General Development Syndicate, Limited, in London, England. After detailing the various hindrances to mining in South Africa, he said:

"Your directors finding the channels of prospecting and investment in South Africa closed, at all events for some time, decided to strike out a new line and to promote a gold mine in another part of the world, namely, the Lake of the Woods, Ontario, Canada, within Her Majesty's domains, and only twelve days easy journey from London. Strictly speaking, the history of this transaction belongs to our next meeting, as the expenditure was not incurred during the period now under review, but it is felt that an account of a very favorable and promising investment may not be out of place on this occasion. I will therefore briefly describe our new venture. In June last I was deputed by your board to proceed to Canada to inspect a gold mining property called the Mikado, situated on the Lake of the Woods, Ontario, about 36 miles southwest of the town of Rat Portage. I found a well-defined quartz reef, 6 to 8 feet wide, which had been stripped for a length of 100 feet, and opened on by pits for a further distance of 314 feet. I took miners with me and tested the reef in several places by large blasts, thus enabling me to get fair average samples. These were assayed at Toronto, the general average showing 4½ oz. per ton. With such a result, and considering the large size of the lode and its favorable geological position, your directors thought it safe to proceed with the formation of the Mikado Gold Mining Co., with a capital of £45,000 in £1 shares, of which £15,000 were reserved for working capital. Of this capital the South African General Development Syndicate hold 28,000 shares, and have call at par of 5,000 more. A competent manager was despatched, arriving at the mine on August 19, and by the end of that month—that is, in only about 10 days—114 tons of ore were quarried and sent to the Dominion Co's. batteries to be crushed, producing 417 oz. of gold, or 2.65 oz. per ton, exclusive of the gold in the concentrates, which ran 2½ oz. per ton.

A few days later 22 tons of ore were milled, which yielded 110 oz. of gold, or 5 oz. per ton, the total value being $7,512. Roughly, that would be about £1,500. Since that time about 700 tons of ore have been quarried, and will be crushed as soon as the ice on the lake breaks up and permits of navigation. The ore has the appearance of being as rich as that previously raised, and should be worth about £5,000. In addition to the lode first discovered another rich vein of about 4 feet in width has been found, and is now being worked, and the last average assays taken by the manager over a length of about 100 feet gave 10 oz., 7½ oz., and 5 oz. 16 dwt. of gold per ton. There is every probability of this reef being equally as rich as the first. A very complete mining camp has been erected; a main shaft 12 feet by 6 feet is being sunk, and at 60 feet deep a crosscut is being driven to cut the lode. A steam hoisting engine and boiler have been ordered, and complete plans have been drawn up for the erection of a battery and the laying out of suitable dressing machinery. These however will not be ordered until the lodes have been further proved in depth. In the meantime the crushing of about 200 tons of ore which was conveyed to the public mill before the navigation was closed is being proceeded with, and we have just heard that of that quantity 144 tons of 2,240 lb. have been crushed, yielding 442 oz. of gold, or a little over 3 oz. per ton. The value of this crushing is about £1,400, and will provide funds for continuing developments. I may here say that only £500 have been remitted to the mine from London, the expenditure having been met out of the gold raised, and there is every probability that no further money will be raised from this side, and that the mine will pay for its own machinery. The area of the property at first acquired was 123 acres, but about 200 additional acres have since been granted on lease, so that the company has sufficient area to admit of subdivision should this prove desirable. As the Lake of the Woods gold mining district is but little known as yet to English investors, a brief description of the locality may interest you. The lake, with its numerous islands and extensive shores, occupies an area of about 80,000 square miles, and only became known to prospectors when the advent of the Canadian Pacific Railway opened up communication. Little progress in gold mining however was made until six years ago, when the settlement of boundary disputes and the discovery of the successful Sultana mine and the opening up of the Regina mine and other rich properties in the Seine and Rainy rivers caused a general influx of explorers, with the result that in every part of the lake's shores, and in spots widely apart, numerous gold bearing lodes have been discovered. The district generally is served from Rat Portage, a town of about 5,000 inhabitants on the Canadian Pacific Railway, and every part of the lake is easily accessible by steamer, rendering the carriage of machinery and supplies easy and cheap. Since the discovery of the Mikado the whole of the immediate neighborhood has been prospected, and a large number of rich properties have been located. Considerable American capital has been attracted, and the coming spring will see widely-spread developments to the rich area. I may here mention that we have been lately approached to take up other properties in the Lake of the Woods, and it is quite possible the directors may appeal to the shareholders to give them a chance of sharing

Col. Engledue's report to his company.

in what are likely to be very valuable concessions. There are very few localities in the world where mining can be carried on under better economic conditions than in the Lake of the Woods. The climate is excellent, supplies are plentiful, labor is cheap, machinery, etc., can be easily transported, and properties can be effectively supervised from England, as the journey from London only occupies 11 or 12 days. The board trust that the acquisition of this valuable Mikado property will more than compensate you for the disappointing results in South Africa, and hope in another six months to show good results producing substantial dividends."

Through the courtesy of the manager of the mine the following will show the extent of the work brought up to the end of January :

Recent progress.

There are two veins on the location, parallel, 400 feet distant from each other on a course 35° south of east. On No. 1 vein is an open quarry on the outcrop 150 feet long, 20 feet deep and 10 feet wide. On No. 2 vein is an open quarry on the outcrop 70 feet long, 15 feet deep and 10 feet wide. A shaft has been sunk on vein No. 1 38 feet east from the lode in the hanging wall, perpendicular, size 6 by 12 feet. The depth at present is 70 feet and continues to be sunk. A cross-cut is driven on the 60-foot level towards the vein, striking it 34 feet distant from the shaft. The size of the crosscut is 4 by 6 feet. Driving in the vein to the right and left is just commenced. Sixteen men are employed in underground work and quarries, and the cost of these works up to date is $4,747.72. Locomotive boilers of 40 h. p., a hoisting engine of double cylinder and double drum of 30 h. p. are at work since December. The equipment is at the surface.

The buildings consist of a sleeping camp for 32 men, dining camp and kitchen, manager's house, assay office, book office, dwelling house, two sheds, blacksmith shop, stable for farm horses, shaft house, boiler house, hoisting engine house, pithead frame 45 high, 8 by 8 feet, sawn timber for a two-compartment shaft and powder house.

The cost of equipment for labor, machinery and materials was $13,945.

A 20 stamp mill will be erected consisting of a Gates crusher, 20-stamp battery and copper plates for amalgamation, four percussion tables, two buddles, two billhartz tables and four classifiers for concentration, two boilers of 40 h. p. each and one engine 40 h. p. and an arrangement for a bromo-cyanide process for extracting gold from tailings. The estimated cost of the mill is $15,000, including building. The quartz runs $60 per short ton on an average.

Reduction Works at Rat Portage.

Part of July 16th was occupied in going through the reduction works of the Gold Mining and Reduction Co. at Rat Portage. The mill has been refitted throughout, and although not running at this date it had the appearance of being in excellent condition and of capacity for treating daily a large quantity of ore. I was informed that the several lots run through had proved very satisfactory. In addition to treating the ores from a number of the company's mines, it will serve as a custom mill, and being situated near several producing mines favorable opportunity will be offered to the owners, not only to have the value of their ores determined by mill run, but also they will be able to utilize the returns in further working their properties without the delay and expense of constructing mills of their own. A system is adopted

by which customers bringing their ores to the mill cannot fail to get fair and generous treatment. Of recent date the Company's manager, Mr. Ahn. writes as follows :

"These works are being added to, and the new chlorination and cyanide plant will soon be in course of construction. These works are a customs mill and equipped with 20 new stamps furnished by Fraser and Chalmers ; any quantity of ore can be treated. There is also separate machinery for testing in any way desired small quantities of ore. Customers taking ore into the works can, if they are capable and responsible, have the works turned over to them so that they can superintend the treatment of their own ores. All parties supplying ore are requested to send in a representative to superintend the work. We wish to satisfy everyone that they are getting fair treatment."

Addition of chlorination and cyanide plants.

The Ferguson mine is situated four miles out on the Government road leading from Mine Centre to Bad Vermillion lake. The road was in good condition and has materially aided the mining interests of the locality. Mining men spoke in admiration of the Government for their liberal policy in opening up this very considerable tract of mining territory, the expense of which could not have been borne by themselves. The syndicate owning the property was organized in London, Eng., early in the past year under the title of the Seine River Gold Mining Co. (Limited), with capital of £100,000, of which the promoters retained £60,000. Shares to the amount of £25,000 were offered and subscribed ; the remaining £15,000 was not put on the market. The locations consist of AL110-111 and K223.

Ferguson Mine.

Several veins have been discovered on the property and the work being done consists in stripping veins, opening pits and sinking shafts. The vein known as the Daisy on location AL111 has been traced 1,600 feet and stripping has been done in several places. Two shafts were being sunk, No 1 had reached the depth of 51 feet and had been neatly collared up for 15 feet from surface, 6 by 10 feet in the clear. Hoisting was being done by windlass and bucket. At 130 feet northwest of this shaft No. 2 had been sunk to the depth of 44 feet. The vein in both shafts showed an average width of one foot. The Government vein on AL110 has been stripped for a distance of 1,000 feet, exposing a vein of 2 feet wide for the entire length. Two test pits of 10 feet each and other lesser pits have been sunk along the vein This vein is 500 feet distant from the Daisy and runs parallel with it, the course being northwest and southeast. The vein known as the Big vein on AL110, is 600 feet south of Government vein and has an outcropping for 1,200 feet. One shaft 8 by 10 feet has been sunk on it 22½ feet and two pits of 14 and 7 feet respectively. The vein averages it is said 3½ feet in width ; the shaft was filled with water. The Finn vein which outcrops about 500 feet from the southwest corner of location 110 runs parallel with the Big vein and extends to and across K223 ; at the beginning of the vein a shaft 6 by 9 feet has been sunk 51 feet, and is filled with water. The vein is reported to be 2 feet in width. Several other veins have been discovered, and limited work done on some of them give showings of free gold The workings are at an elevation of 150 feet above Shoal lake, and near the public road.

Exploration work carried on.

Two miles from the mine, via the Government road, brings you to a landing on Shoal lake, and by boat Mine Centre is quickly and easily reached by a sail of two miles. The road which runs into Mine Centre by a more circuitous route is kept in an excellent state for travel.

Camp buildings.

The buildings of the Ferguson camp consist of residence and office, 16x32 feet, sleeping camp, 12x16 feet, boarding camp, with wooden walls and tent covering, 16x30 feet, warehouse, 16x20 feet, assay office and a small powder house 300 feet from the workings.

The force of men employed varies from 15 to 20 and work is chiefly done by contract.

Requirements.

Before drifting is done in No. 1 shaft ladders must be securely fastened at a proper incline, with rests at short distances. When machinery is introduced for hoisting the ladder way must be divided by casing from the part of the shaft used for hoisting. A railing is required to be placed around the mouth of the shaft, only leaving space for working, and when the shaft is not in use this opening must also be protected with guards. The air was bad in the bottom of this shaft, which will be remedied by the use of air compressor drills when used, and meantime may be improved by keeping a heated stove at the surface with an air pipe feeding it from the bottom of the shaft. All unused pits and open cuts must be fenced, or notices posted giving warning of danger. Shaft No. 2 must be provided with the same protection as shaft 1, and the ladders in the man-way properly arranged and made secure against accident. The Inspector's book was left with the Superintendent of the mine, Mr. Arthur W. B. Whiteley, with copies of the Mines Act, and a special request to have the foreman of the mine examine the parts relating to the responsibility of contractors and the regulations for conducting work.

In a letter under date of January 30th from Mr. Charles J. Hollands, Crown Lands Agent at Fort Frances, I am informed that Mr. Varty has recently arrived from India to take charge of the property. Mr. Varty had gone out to Duluth to bring in another hoist and pump, and two-stamp Fraser and Chalmers mill for testing purposes.

Hillyer Mine.

The Hillyer or Lucky Coon mine, half a mile south of the Ferguson, was standing idle on July 7th, when I visited the locality. The two shafts which had been sunk were filled with water; drifting had been done to a limited extent and a small quantity of ore obtained and treated in the five-stamp mill.

Foley Mine.

The Foley mine, two miles and a half west of Mine Centre, was visited in company with the superintendent, Mr. R. H. Flaherty, on July 8. Work had been suspended since the first of the month, but would be recommenced upon the arrival of Mr. J. C. Foley, who had been absent for a length of time on business in connection with the property. On my return to Rat Portage a few days later I learned that we had passed each other on the steamers on Rainy river, as he was going up to the mine. Work was immediately resumed, and I am informed it has been continued through the year. The follow-

ing notes taken when at the mine will show the advance in work since the entries made in the Inspector's book the previous year by the Director, who then inspected the property.

No. 5 shaft, sunk on No. 5 vein, AL75, had reached a depth of 113 feet, making additional sinking since last entry of 69 feet. At the bottom of the shaft a drift had been run in south 12 feet. The measurements were made previously by the superintendent of the mine, the shaft now being nearly filled with water. Progress of development work.

The shaft known as the North shaft, Bonanza, is on location AL74, and was sunk a depth of 100 feet to level 1. It is sunk a further depth of 50 feet to level 2, and continued a further depth of 50 feet to level 3, also below the floor of level 3 to the depth of 8 feet, making the total depth of the shaft from the surface 208 feet, being 202 feet additional sinking since last entry. Level 1 has been run south of the shaft 61 feet, and north of it 37 feet. At level 2 a south drift extends from the shaft 105 feet and the north drift 10 feet. Level 3 has been run in north 70 feet from the shaft and south of it 10 feet. The dip of the vein from the surface to level 1 is 80° east, from level 1 to level 2, 89°, and again from level 2 to level 3, 81°. The width of the vein at the bottom of the shaft is 30 inches, and the average width from surface to bottom is 38 inches. No additional sinking on shaft No. 9 has been made since last entry.

Ten miners had been constantly employed in the mine, and about an equal number of laborers doing outside work.

Three 3½ inch Ingersoll drills had been in regular use in the mine, and four part of the time.

No new machinery had been introduced since the last inspection. What was then on hand had been properly placed, and in use proved entirely satisfactory. Machinery and equipment.

An additional water tank had been placed in the engine room of 2,900 gallons capacity, and with the former one of 1,900 gallons gives the total of 4,800 gallons, sufficient to supply the boilers for 48 hours.

The power house, built of stone, is placed at the distance of 800 feet from the workings.

About 400 tons of apparently free milling ore had been taken from the mine during the development stages of the work, the policy being to leave as much in the mine as possible until required for future milling.

The road leading up from the dock had been completed to the north shaft.

The machinery, though standing idle, was apparently in good condition. The signal service which the superintendent stated was perfect extends from the engine to the hoist, a distance of 1,200 feet. A five-eighths plough steel cable is used, running over pulleys placed on a trestle-way for most of the distance from the engine to the place of hoist. It is noteworthy that no accident has ever occurred at the mine.

The projected twenty-stamp mill.

The superintendent informed me that on Mr. Foley's return, which was then expected at any day, work in all probability would be immediately commenced towards the construction of a twenty-stamp mill on the border of the lake where supplies would be easy of access. A sufficient quantity of good milling ore he considered had already been exposed in the mine to warrant such an outlay. The distance from the north shaft to the proposed mill site I was told is 3,300 feet. In view of extensive uture working I considered it necessary to leave the following instructions, which were included in the entries made in the Inspector's book and left with the superintendent :

"The North shaft must be refitted and put in good working condition for permanent work before future mining operations are commenced. In places the walls require trimming and the ladder-way cased off from the part of the shaft used for hoisting; the ladders, which are now perpendicular and in bad condition, must be renewed and placed at proper incline and with suitable rests. Guards must be placed at the approaches to the shaft in all the levels and coverings at places of entrance when not in use. All unused shafts and open pits require fencing, or notices posted up giving warning of danger. The fly wheels and other exposed parts of the machinery must be provided with railings."

Report of progress to the first of December.

The following report of the manager, Mr. Foley, brings the measurements of the several workings up to December 1st :

North shaft, depth 210 feet. North drift, 100-foot level, 37 ft. 8 in.; south drift, 61 ft. 7 in., width of vein 24 in. North drift, 150-foot level, 63 ft. 3 in.; south drift, 165 ft. 7 in.; width of vein 21 in. North drift, 200-foot level, 77 ft., south drift, 66 ft. 4 in.; width of vein, 26 in. On the 150-foot level an upraise or winze was started in the south drift 46 feet from the shaft and carried 21 feet 8 in. on December 1. On the 150-foot level a winze was started in the south drift, 75 ft. from the shaft, which measures 18 ft. 5 in. On the same level a winze was started in the north drift 32 ft. from the shaft, measuring under the same date 19 ft. 5 in. On the 150-foot level a cross-cut to the Jumbo vein was made at 160 ft. from the shaft in the south drift and has been carried 52 feet, and Mr. Foley states that the vein must soon be reached, as there remained only 19 ft. on December 1. No. 5 shaft, depth 114 feet. North drift, 62 ft. level, 47 ft. 6 in.; south drift, 83 ft. 2 in.; width of vein, 25 in.

Lucky Joe vein.

Every indication points to Lucky Joe being one of the most valuable veins on the property. As depth is reached the vein strengthens and gives every indication of increased richness and permanency. The sinking on this vein has reached a depth of 22 feet, and a drift has been started south measuring December 1, 16 ft. 7 in., the width of the vein being 16 in.

Test pits on other veins.

During the season the following test pits have been put down on other veins, namely :

AL74, Northeast shaft, vein No. 9, 31 ft.; widthof vein, $4\frac{1}{2}$ ft.; assays run from $8 to $66.

AL74, No. 3 shaft, 10 ft.; width of vein, 3 ft. 4 in.; assay values from $6 to $31.

AL74, No. 1 shaft on West vein, 12 ft. ; width of vein, 20 in. ; assay values from $5 to $16.

AL75, No. 1 shaft, 16 ft. ; width of vein, 15 in. ; assays from $7 to $43.

AL75, No. 3 shaft, 14 in. ; width of vein, 3 ft. 4 in. ; assays from $8.50 to $72.

AL75, No. 4 shaft, 19 feet; width of vein, 22 ft. ; assay value of 75-pound sample, average $62.

AL76, No. 1 shaft, 13 ft. ; width of vein, 20 ft. ; assays run from $2 to $6.

In a communication received from Fort Francis of 30th ult., Mr. Charles Hollands, Crown Lands Agent, says :

"Work at the Foley mine is being pushed forward with great energy. The mill is now in perfect running order with the exception of two vanners which are on their way to the mine from Tower, and Mr. Foley told me yesterday that he had every reason to expect that he would be ready to start up by the 1st of February. Their principal shafts are on the Bonanza vein, parallel to which is a large vein known as the Jumbo on which no shaft has been sunk, but a drift has been run at right angles to the Bonanza at the 150-foot level. This has struck the Jumbo in about 90 feet, 30 feet further than they expected to have to go, consequent on the different dip of the two veins. The vein where they have struck it is about 5 feet and is heavily mineralized. It has not yet been assayed, but the pannings indicate that it carries more free gold than it did at the surface, which was about $10 to the ton."

Preston Mine.

The Preston Gold Mining Co. is operating the Oliver location near Mine Centre and has several test pits and shafts sunk. Mr. Charles Hollands in writing recently says :

"From the Preston Mine I hear nothing but the most satisfactory news The shaft is down 50 feet, or was when I was there about three weeks since. Just previous to that the vein had pinched in to about three inches, but it has been steadily widening for the past month and is now wider than it has been at any time. Mr. Preston is also bringing in a two-stamp Fraser and Chalmers mill."

Empress Mine.

On July 20th Mr. Peter McKellar of Fort William accompanied me to the Empress gold mine, via C. P. R., 151 miles east of Fort William. We arrived at Jackfish station early in the day and found a small steam tug awaiting our arrival to carry us across a point of the bay to the landing from which the road leads up to the mine, a distance of between two and three miles. This property was discovered by an Indian and brought to the notice of McKellar Bros. in June, 1895, and was soon after located by them. It consists of R569 and the associated lots 567 and 568, each containing 160 acres, making a total of 480 acres. R569 location has been sold to a local company organized under Ontario laws, known as the Empress Gold Mining Co. and stocked for $100,000 with 20,000 shares of $5 each. One-half of the stock was reserved for working capital ; 8,000 shares have been sold to local investors for $2.50 per share ; the remaining 2,000 shares are still held in the treasury unsold. The officers of the company are : President, Walter Ross, Rat Portage ; vice-president, Peter McKellar, Fort William ; J. T. Horne, managing

Empress Gold Mining Co.

director; Mr. Peters, mining and mill manager; George McEdwards, secretary, Fort William; G. A. Graham, treasurer, Fort William; Mr. Lawrence Newlands, assayer. The head office is at Fort William. A force of 30 men was employed, including 18 miners, 6 mill men, and 6 on outside work. On the Empress location there are five veins varying from 3 to 5 ft. in width, all of which join and form one leading vein running east-northeast and west-southwest, and has been traced for the distance of a mile by test pits and cross-cuts across the adjacent locations. The dip is 45° south.

The Empress location.

On this location there is also a cross-vein of 3 feet wide which cuts nearly at right angles the other veins, and on which a shaft has been sunk 12 feet. About 400 feet from the eastern boundary of the location a test shaft has been sunk 26 feet, exposing the quartz from 6 to 8 feet. About 300 feet west of this shaft a test pit has been opened 11 feet deep, showing 3 feet of gold bearing quartz next to the hanging wall, the foot wall not having been reached.

Workings.

The main workings consist of drift No. 1 run into the hill following the vein for a distance of 46 feet. A stope is being made near the mouth of the drift. No. 2 starts north of drift No. 1 20 feet, being driven 72 feet. The vein shows a width of from 6 to 10 feet. The drifts run parallel with each other, as also the viens, and are of the same dip in each drift. The walls of slate associated with hornblende-schist are well defined. Eighty feet south of the drift a shaft has been sunk on one of the viens 20 feet and is well collared down 12 feet to solid ground, showing a width of vein at the bottom of 3 feet. Between 350 and 400 tons of milling ore are lying on the dumps.

The mill.

The ten stamp mill of Fraser and Chalmers make was expected to be started up during the present week. The stamps of 850 lb. will be started at 8 in. drop at 90 per minute and the screens at 40 mesh. A 7 by 10 Blake crusher was in place for use; also two copper plates, silver plated, 4 7-12 by 8 feet, with mercury trap below, a Brown hydraulic sizer, and three Frue vanners, one of 4 feet with corrugated belt and two of 6 feet plain belt.

The water supply is obtained from a small lake, 1,000 feet north of the mill and at 240 feet elevation above it, to which a $2\frac{1}{2}$-inch pipe inside diameter has been laid. Its efficiency was first tested the day of my visit. There is also a small ever running stream below the mill from which a winter supply of water may be obtained if required by the use of a pump and reservoir.

From 500 to 600 cords of wood have been provided for use, and a large supply for the future is easy of access when needed.

The mill building is 34 by 27 feet with vanner house 28 by 40 feet connected, and engine room 18 by 28 feet attached. The total elevation is 45 feet. The structure is substantially built and convenient for use. The ore is received in the top of the mill over a trestle tramway laid with double track for the distance of 612 feet north from the mill to the mouth of the adits driven in the hill. The tramway has a grade of two and a half feet in 12 feet, and the cars will be run by gravitation; the loaded car going down on one track will carry the empty car back over the other track to the mine. The machinery consists of one tubular boiler $4\frac{1}{2}$ by 12 feet, 60 h. p.; and one engine, 12 by 20 in., 50 h.p. Both are well set and thoroughly equipped for use.

The other buildings consist of a boarding house, 30 by 30 feet, assay office, store house, blacksmith shop, and powder house of stone 600 feet from the mine.

Instructions were given to have the open unused shafts, pits and cuttings fenced; also the stairways in the mill and the exposed parts of the machinery to be supplied with suitable railings. The mill work was not entirely completed, and the mill manager informed me that these necessary appendages would be added as the utmost care would be taken to provide against accidents. Instructions.

The Inspector's book with copies of the Act and notices to be posted up were left with the managing director, Mr. J. P. Boland.

After preparing the foregoing report on the Empress the following interesting communication was received from the pen of Mr. Peter McKellar, who has been for a long time intimately associated with mining interests in western Ontario. His paper gives the present condition of the mine and confirms much that has been stated respecting other locations and mining districts. He says: Peter McKellar's report on the mine.

"The Empress gold mine is in excellent condition for working 25 to 30 tons of ore per day. The mill is complete with its admirable outfit of machinery. The mine was started about one year ago, and the mill was put in operation about the beginning of August last and closed down in the latter part of September. It was idle part of the time, getting new machinery to work well, and more especially on account of the unusually dry season, which rendered it necessary to excavate a long ditch to let the water of the larger lake into the smaller one. Five of the veins were tested by milling, and all showed pay ore. Four bricks of gold were produced from the free milling; the concentrates which hold a considerable value have not yet been treated. The last run of the mill gave a brick of 33 oz., which I think will average fully $18 an ounce. I am not in possession of all the particulars to the closing down of the mill, but strict account was kept of the second mill run and it showed that the free milling yield would pay more than the running expenses working on the unselected ore. The last mill run gave better results than either of the others. The mill was closed down in the latter part of September for the purpose of preparing the mine for winter work, putting in a compressor plant and driving in a tunnel above the mill at an elevation of 140 feet below the highest outcrop of the veins. A length of 400 feet will intersect all the veins and save hoisting and pumping for the great quantity of ore that is above that level. The compressor was started about two weeks ago and is doing good work. The tunnel is now more than half way and has cut through the first vein belt, which shows lots of ore that pans well in gold One of the quartz ribs is 8 feet wide of quartz, fine looking ore, samples of which I have seen. Only 150 feet more is required to be driven to cut through the last or north vein, which showed the best, and upon which the most work was done at surface. After the tunnel passed through the first vein and an examination proved satisfactory Superintendent Peters went to the south shore and secured practical drilling machine workers. He returned with about a dozen men to the mine and he proposes starting the mill full blast in a few days, as he

anticipates no trouble in supplying it with ore from the tunnel. Things now are in good condition for working the mine advantageously. The buildings have been well fitted up, including a comfortable dryer for the miners. The wood supply for the summer is being chopped. The mill, compressor and all the machinery are in good order. The tunnel has been opened so that drifting and stopping can be commenced right away and the mine worked economically. There are in the Treasury for working capital nearly $20,000 cash and over 35,0000 shares of stock.

Other locations in the vicinity of the Empress.

"Within the last year a large number of claims have been located in the vicinity of the Empress mine. Mr. D. McIntyre has taken up up two or three locations on a large vein of fine looking gold bearing quartz that lies two to three miles to the north of the Empress. It is said that he sold the property to Toronto parties for $10,000 a few days ago.

"Mr. R. Walker told me yesterday that he was engaged to take charge of a party of miners to open out Mr. T. Gaddes' gold claim, which lies about 1½ miles to the east of Jackfish. Mr. Wm. Murdoch, P. L S., has been for some time past engaged surveying locations in the vicinity of Jackfish. It is generally reported here that the big trap dike that intersects the formation near the Jackfish railroad tunnel has been thoroughly tested in Toronto and found to carry gold in paying quantities; and that Mr. Murdoch is surveying claims on it, along with others, for a Toronto syndicate. The Mocon gold claim lies about two miles to the west of the Empress. There are two or three gold bearing veins on it. A party of miners were engaged by Mr. D. F. Burk and associates to run a drift on one of the veins 100 feet into the mountain. The work was completed a few days ago, but I have not heard what the test of the ore gave. I understand the work will not be resumed until after the opening of navigation. The gold discovery made last fall a few miles to the east of Schreiber created a lot of excitement and a number of locations were surveyed, but the deep snows stopped work for the winter. There are now a large number of the people of the district as well as a number of capitalists of Toronto and other places interested in the Jackfish gold fields, and no doubt the coming season will witness much mining activity here as well as in many other places between here and Lake of the Woods. The mining operations in progress now are far in excess of that of previous years, and worked at greater depths in many cases. Information received shows that many properties are developing well, especially so in the case of the deeper (100 to 300 feet) workings as shown by the Empress, Sawbill, Foley, Sultana, etc. Mayor Marks has samples with the coarse gold showing here and there, just in from the lower workings of the Sawbill mine. He states that there are 7 to 8 feet wide of good ore at the bottom of the shaft which is about 160 feet deep, much wider than it was at surface. They are drifting both ways on the vein with a good showing of ore both at the 60- and the 120-foot levels. The Seine river gold bearing belt may be said to be

The Seine River district.

100 miles or more long, or from Lac des Mille Lacs to Rainy lake, with branches leading off. A great many gold claims have already been taken up along this stretch, as those at Partridge lake, Osinawe lake, Hawk bay, Sawbill lake, Steep Rock lake, Harold lake, Shoal lake and many others. Hundreds of people are interested in these gold claims In fact many from almost all classes of the community are becoming gold hunters. I was out as far as Harold lake late last fall and met many parties exploring, some of whom I never expected to see in that business, as teamsters, jewellers, etc. Every one had claims and samples of gold bearing quartz, some of which I took along and found gold in them in paying quantities. There are many other gold fields besides this one, some 40 to 70 miles north of the C. P. R., as at Minnietakie lake, Abram's lake and Sturgeon lake. The Seine valley is rich in iron as well as in gold. The Atik okan range is one of the finest bodies of iron ore in the world, both in regard to quality and quantity. There are large deposits of iron pyrites, and no doubt other valuable metals and minerals will be found when examined. There is a lot of fine timber and some good soil along the route. There will be a large influx of people here the coming summer. I know of no locality that is in more need of a railroad than the Seine River valley, nor of a railway that could be built for the same cost that would benefit the Government and the people at large so much."

Riches of the Seine valley.

Crystal Mine.

My visit to the Crystal gold mine was made on May 24th, via the public waggon road leading out from Sudbury to Boland on lake Wahnapitae, a distance of 18 miles. The old travelled roads and lumber roads were taken for a considerable part of the way, the new part having been but recently opened for constant travel. The Government expenditure made during the summer has greatly improved it, and it will become the principal route from Sudbury to the lake when going over to the Wahnapitae gold district, which is on the opposite end of the lake at a distance of 12 to 15 miles. In the lake are many islands, and at times it becomes treacherous to small crafts crossing it. The winds surge with great velocity down the long open stretches of water, causing rapid currents and heavy sea swells, to which may be added the occasional sudden squalls of wind and torrents of rain which cause the inexperienced mariner to hail with inexpressible satisfaction the Crystal mine harbor or the Boland dock, as was my experience on the perilous return. The lake is beautiful and affords exquisite delight in crossing on a pleasant balmy day. A small steam tug should be supplied for travel when the gold properties are largely opened up, which may be at not a very distant date.

Wahnapitae lake.

Workings of the mine.

The 25th of May was spent in examining the Crystal mine and some adjacent properties Mr. R. McConnell, the manager, after whose name the mine is popularly called, was absent, but Capt. Allan McDonald who had charge courteously accompanied me on the round of inspection. Everything in the camp and about the workings is kept in a neat and attractive manner. No additional sinking had been done in the old shaft since last entry. The

south drift at the bottom of the shaft had been extended 90 feet, making a total of 100 feet. The drifting north of the shaft is 80 feet, making the total length of this drift 105 feet. At 60 feet from the shaft a raise of 4 by 6 feet had been made 35 feet. At 85 feet from the surface a drift had been driven in 15 feet, which turning an angle south continues on a curve to the west for 30 feet. At the same depth in the shaft a drift has been run in west of the shaft and turns south 15 feet, making the total drifting 60 feet at this depth. Three men were engaged in drifting west of the shaft on the vein of 2 feet width, with a dip of 25° south. About 150 feet east of the main shaft and about 45 feet below the top of the hill (or mouth of the main shaft) an incline adit has been driven in southwest 60 feet, following the vein, and thence turns an angle north 20 feet. Three men were working at this point. Another drift starting at the angle is driven in south 32 feet. The total drifting is 112 feet. At 350 feet north of the main shaft another shaft 4 by 7 feet has been sunk 35 feet, following a perpendicular vein for 10 feet, then turns with the dip of the vein southward 45°. The shaft was timbered down to solid formation; work here was suspended for the present. About 120 feet west of the main shaft a 4 by 7 foot shaft had been sunk 37 feet, following the vein with a slight dip south. The shaft was partly filled with water No new machinery had been added. Twelve men were employed, six of whom were on underground work with day shifts only. About 200 tons of fine appearing ore were on the dumps. All ore however which did not interfere with the development work was left standing in the workings, to be lifted when required for use. I directed that the unused shafts should be fenced or covered over to prevent accident; also that the blacksmith shop should be removed from the shaft house over the main shaft to insure greater safety from fire while the men were working in the mine. The mine is one of the most promising in the district, and may be operated on a large scale in the near future. Necessary entries were made in the Inspector's book and left with the captain of the mine with copies of the mining laws containing amendments to the Act.

I am indebted to the Sudbury Journal of December 17th for the following:

Getting ready for practical work.

"The annual meeting of the Crystal Gold Mining Company of Wahnapitae was held in Pembroke on Tuesday last. The principal business was the election of directors, and it resulted in the choice of Hon. Peter White, Thomas Mackie, M.P., R. McConnell, James Klock, M.P., and Robert Bowie. Afterwards the directors elected Hon. Mr. White, president; Mr. Mackie, vice-president; and R. McConnell, managing director, with W. R. White, Q.C., as secretary. The company have decided to put in a full set of machinery in the spring, including a five-stamp mill. A large amount of development work has already been done and about 500 tons ore mined and four times that much in sight. The company think they have the finest mining properties in the world, and confidently look forward to such a development when their machinery gets in motion as will prove their claim."

The January issue of the Canadian Mining Review of Ottawa, says that the company has contracted with the Jenckes Machine Company for the construction of a five-stamp mill. The mill is to be built on the specifications of Mr. John Hardman, the well-known Montreal mining engineer.

Last Chance Mine.

The Last Chance mine is situated on lot 4 in the fifth concession of the township of Rathbun, which comprises 238 acres, and is about one mile east of the Crystal mine on lake Matagamasing. There is a short portage between lake Boland and this water from which one mile brings the boat to the landing at the campers' building used for cooking, with a sleeping apartment attached. One tent is called into requisition for accommodation. The property was discovered in August, 1892, by Henry Ranger and Joseph LaRose, who yet hold an interest in the mine. Mr. D. O'Connor of Sudbury has acquired an interest, and gives directions about the prospecting work. On this account the property is popularly known as the O'Connor mine. Mr. H. F. Downey, an old miner, was sent out with five or six men to assist him to open up the property. Two principal parallel veins have been discovered running east and west and a slight dip to the south, with several stringers or small veins running in the same direction. Work has been done on the two principal veins, a quarter of a mile back from the lake, and near the middle of the lot one of the veins had been traced by the outcropping quartz for a quarter of a mile, and the other for fully 300 feet. Stripping had been done in several places on the longer traced vein and a test shaft sunk twelve feet. Another shaft in which work was being done at the time of my visit was down eight feet, showing sulphide iron mixed with the quartz. The other larger vein, which was discovered near the building and hardly noticeable at the surface, has been traced for nearly a quarter of a mile, and has been opened by stripping for a few hundred feet, showing the width of vein to be 14 inches. On the hill above the lake, say 150 feet elevation, there is a large band of mineral quartz, the small stringers running in the same direction as the other veins; some of them when opened showed liberally free gold. Should these several surface leads converge as depth is attained and form one general leader or vein, assurance will be given of a large supply of paying ore. On returning to the camp from our survey of the property some very fine specimens of gold were shown to me which had been taken from the place of working during our absence. The property is favorably located and easy of access, and from present appearances presents an inviting outlook.

Comstock Mine.

On WR 40, comprising 18 acres, near Boland lake and adjoining the Crystal mine property, prospecting had been done some time previous to my visit. One-half of the property I was informed is now held by Mr. W. Ross, of Toronto, assignee, and the remaining half by Messrs. Louis LaForest, and T. Maloney, of Sudbury. The work done was on a vein running southeast and northwest with a dip of 80 degrees south, by a cut opening the vein for a distance of 100 feet and sinking a shaft fifty feet. Another vein 17 feet from the former, which runs nearly parallel and forms a junction with it, was stripped for 75 feet and a test pit of 16 feet sunk at the junction of the two veins. In the deepest shaft the vein showed a width of 16 inches.

Several surface stringers running parallel with the larger vein and stretching across a belt of nearly 100 feet have been carefully examined and apparently are feeders to them; free gold may be discovered in a number of them, as well as in the large vein. All work has been suspended, I was informed, for the want of capital. Mr. D. O'Connor has become the owner.

Of this property Mr. O'Connor writes under date of February 1st: "I have 10 men working on Comstock and they are now at the depth of 65 feet. This lot is known as WR 40. Assays run from $60 to $220 per ton, average samples. There are several small veins on the property which carry free gold plentifully. In the main shaft at 65 feet we found free gold. It is a true fissure vein beyond doubt. This lot adjoins the Crystal."

COPPER.

Canadian Copper Company.

Copper Cliff Mine.

At the date of my first visit to the Copper Cliff mine (May 22), 80 workmen were engaged on underground and outside work. The work being done in the mine was on the 8th, 9th and 10th levels. In level 8 since last measurement, stoping with upraise has been extended south 60 feet in length, and 47 feet in width, stoping north 20 feet in length, 22 feet in width and raise of 28 feet, making the total length of the stope 180 feet measuring near the roof of the level. A large quantity of ore had been shot down, principally from the south stope, and was being lifted from the mine. The shaft was continued from the 9th to the 10th level, a distance of 70 feet at an incline of $77\frac{1}{2}°$, as above, and the same incline sunk 27 feet below the floor of level 10, where a pentice was completed for further sinking to level 11. A vertical winze 7 by 8 feet had also been sunk in the ore body from the 9th to the 10th level. The stoping southeast had a length of 38 feet, making the total length of drift and stope 138 feet, and an additional 20 feet width, making the total 37 feet. A large quantity of ore was stoped down ready to be taken out with a quantity of unstoped ore beneath. In level 10 a drift had been run in west from the shaft 13 feet, thence turning at right angles south and extending towards the ore body 44 feet. It was expected the ore would be reached at the further distance of fifty feet. A large quantity of ore was being taken from the mine daily and treated in the usual way. No new machinery had been added for inside or outside work at the mine; the necessary repairs had been kept up and all was running smoothly. Two new steam signals had been placed in the rock house which gave timely and unmistakeable warning of danger before dumping the ore from the skip cars.

The smelters.

The two smelters were in good running order and treating the usual quantity of ore daily, although the same quantity of matte was not obtained. The manager stated that the ores failed to sustain their former high grade, and to obtain the same quantity of matte a larger quantity had to be run through the smelters, which necessarily increased the cost of production. Full sets of copper tubes have been purchased at very considerable expense to replace the steel ones in the two boilers as well as the water-heater at the smelters, as the impure water used quickly corrodes the steel. New 12 feet ties and 72 lb. rails per yard had replaced the old ones on the trestle-way,

Railway track and roasting yard.

and the extension trestle will be supplied soon with the same. The former rails, 55 lb. per yard, have been used on the sidetrack east of the mine, which had been relaid and extended a distance to accommodate 25 cars. A new and very superior locomotive had replaced the old one, and was doing its work efficiently in hauling all trains in use by the company. The roast yard is of sufficient dimensions to spread over it 45 roast heaps at one time, some of which contain 1,500 tons of ore, requiring from two to three months to roast; others containing 800 tons can be roasted and cooled off in six weeks. About one-eighth of the roasted ore, chiefly from the outside of the heaps, is returned to the heaps again as insufficiently desulphurized. The large quantity of 25 car loads of green ore, 20 tons each, was being brought daily from the three mines to the roast yard to replace the roasted ore as it was removed to the smelters. About 18,000 tons of roasted ore was on hand.

Recklessness in blasting roasted ore.

As a precaution against accident one man (an experienced miner) was employed to charge the holes and fire the blasts in breaking down the roast beds in the yard, and instructions were given to have no blasting done where the ore was dangerously hot, but either without knowing or giving attention to former instructions the man continued sometimes to insert charges and do blasting when the ore was in a very heated state, unknown, I have reason to believe, to the contractors who roast the ore and deliver it at the smelters. On this account I considered it necessary to issue an imperative order to discontinue the practice as dangerous within the meaning of the Mines Act.

The attention of the workmen and all parties concerned was called to the section in the amended Act relating to this matter. A notice was inserted in the Inspector's book as follows: "When inspecting the roast yard at the Copper Cliff mine (May 22nd, 1896), I was informed by Mr. Daniel Sherk, who was then employed to do the blasting of ores on the yard, that sometimes blasting had been done in very hot ore. I therefore give notice that such practice must positively be discontinued, as it is dangerous in the meaning of the Mines Act. See sec. 10, chap. 16 of amended statute assented to on May 5th, 1894."

Locomotive and car building.

The locomotive and car building had been enlarged by an addition of 80 feet. A large quantity of wood was on hand, a considerable part of which had been piled along the eliptic track, which had been completed and in use by the cars. The mine and all outside works were in good condition.

The sanitary condition of the place is carefully looked after, and the public school is vigorously sustained. Religious services are conducted every Lord's day in the place, in addition to a well supported Sunday School.

Seven acres of land near the mine was being cleared, levelled and neatly fitted up for pleasure grounds.

Second visit to the mine.

On July 24th and 29th I again inspected the mine and all outside work. In level 8 the stope north had been extended 20 additional feet, making a total of 200 feet in length; the width was also extended 8 feet, making a total 36 feet, with a raise of 28 feet. The work had been confined chiefly to removing the body of broken down ore and under-stoping to the floor of the level. At this date a large body of ore still remained north next to the boundary.

Progress to the end of year.

Captain Davis in a recent letter informed me that the work in this level at the end of the year showed a stope at the north end 100 feet long, 32 feet wide and 26 feet raise. The south end was 141 feet long, with an average width of 40 feet, making a total of 241 feet in length, average width 40 feet, and 65 feet elevation. No extension to the boundary had been made in the ninth level since last measurement, the work having been confined to removing the large body of ore broken down and understoping the ore beneath it. The captain's report bringing the work up to the end of the year shows a stope of 120 feet in length, 37 in width, and an elevation of 55 feet. In the tenth level the drift has been extended since last entry in the Inspector's book an additional 64 feet, making the distance in the line of the drift 108 feet. Added to 13 feet west of the shaft to the angle south, this gives a total length of drift and stope from the shaft to the winze of 121 feet. The drift had been enlarged by a stope near the winze for a length of 32 feet and width of 23 feet. Captain Davis, in bringing the work up to the end of the year, states: "We have an opening (stope) in level 10 north of the winze 63 feet long, 25 feet wide and 50 feet high. South of the winze it is 33 feet long, 25 feet wide and 50 feet high."

Smelter No. 2 had been shut down six weeks for repairs and had been started up again on Saturday 25th; meantime the small No. 3 furnace had been running during the interval of repairs. Three furnaces are kept on hand, but only two are operated, leaving the other as an auxiliary. The additional furnace will be set up in a separate place and can be started up at any time without waiting for the removal of one and replacing the other. A new slag pit has been prepared and will be joined to No. 2 and be lifted by the same elevator to the tram track above. The roof on part of the smelter building will be raised and necessary changes made for this new work. A Root Positive Blower, shipped from Cleveland as an auxiliary, was being placed in position for use in the event of the other requiring repairs, so that no delay in work would occur. The two furnaces were treating 170 tons of ore daily. The total quantity on the roast beds was about 48,000 tons.

Prospecting a new deposit of ore.

About a quarter of a mile northwest of Copper Cliff, at a point known as the Jones mine, prospecting had been done some time ago with a diamond drill, and several bores had been put down. At the date of my visit to the place in company with the general manager a number of men were engaged in sinking a few test pits, opening crosscuts and stripping the deposits of ore. An exposure of nickel ore at one point was made of 40 feet in length and 80 feet in width. At another place the ore was exposed for 150 feet in length and 80 feet in width. This prospect work was being done with a view of obtaining future supplies of ore for smelting if required. From the deposits there is an easy down grade to the top of the rock house, and apparently an immense supply of ore accessible which may in future be called into requisition should the supply from the present large producing mines prove insufficient to meet the demand of the market.

The Loopline railway to which reference elsewhere has been made is completed, having the short diameter of 700 feet across. The enclosure as well as outside the track has a capacity for storing 10,000 cords of wood,

and a large quantity had already been placed on it for future use. In the centre of the circle has been placed a steam hydrant which is connected by a three inch steam pipe laid from the boiler room, and may be called in use at any time in case of fire. It commands the whole radius of the wood yard: 400 feet of hose are kept convenient for attachment to the hydrant. Woodyard.

Just previous to my visit the Company had sustained very heavy damage by a cloudburst which had flooded a large part of the works about the smelters, roast yard and trestleway. The immense torrent of water washed away part of the cribbing that sustained the trestle-track. To raise the track again the cribbing has been rebuilt for a distance of 700 feet. All the reservoirs and drains were filled with earth, as the waters swept over them, and serious derangement occurred generally to the outside work. At a very considerable outlay the whole had been put in good shape, with precautionary protection against any derangement in the works should a similar sudden and unwelcome visitation occur again. Damage caused by a cloudburst,

The general manager informs me that a fire occurred on Christmas morning last in No. 2 smelter building, resulting in damage of about $2,000, but now (January 6th) the smelter is undergoing reconstruction. and by fire.

The total number of hands employed by the Company exceeds 350, besides the 75 or 80 men engaged by the contractors on the roast yard work.

The mine as well as all outside work was kept in a good condition at the date of this inspection.

A fatal accident is reported to have occurred on October 29th, by which David McGregor, a young man about 25 years of age, was killed by the falling of rock from the roof in the eighth level of the mine. A coroner's inquest was held and the following verdict rendered: Fatal accident in the mine.

"We believe that deceased David McGregor's death was caused by being struck by rock or ore falling from the roof of the slope in the eighth level of Copper Cliff mine. We are of opinion that there has not been sufficient inspection and testing of the roof of the mine where blasting is being done (especially where water is coming through the roof or winze) to properly protect the workmen."

Not being requested to investigate the cause of the accident, I cannot speak decisively as to the condition of the place in the mine where the accident occurred. One of the requirements of the workmen however is to carefully scale the walls as the work proceeds, and to insure further protection against accidents of this class from four to six men are sent into the mine after midnight on Sunday, when the mine is free from smoke, to examine the places of working and if any part is found dangerous, to have it removed preparatory to the work of the Monday morning shift. Thus daily and weekly examinations of the walls at the place of working has been a usual and wise provision against accidents.

The Stobie mine was visited on May 20th and the entire day was spent in company with Captain Davis, who has charge of all the mines of the Company, in carefully looking over the work both inside and outside. Eighty hands were employed in and about the mine and from 150 to 180 tons of ore Stobie Mine.

Stobie Mine.

taken out daily with day and night shifts. The work was being systematically conducted and precaution taken against accident to the workmen. The captain informed me that the walls were frequently examined, besides the constant trimming done by the men as the work progressed. A large field of ore was being opened up in the second level and it was intended to constantly and regularly carry on the work throughout the season. The ore after being crushed was taken over as usual to the Copper Cliff roast beds. The following notes entered at this date in the Inspector's book will show the additional extension of work since last inspection :

"Additional stoping in large open pit 17 feet, making total length 133 feet. Additional stope in width 7 feet, making total 67 feet. No addition in depth, same as before, 111 feet. A winze 7 by 7 feet had been sunk from floor of level 1, or open pit, 60 feet. Also a drift 7 by 7 feet had been driven in westerly under the tunnel of open pit No. 2 for 65 feet. An incline shaft at angle of 65° had been sunk from floor of level 1, 75 feet to level 2. The shaft had also been changed above the floor of level 1 to an angle of 60° for the distance of 81 feet and continues upwards to the further distance of 72 feet at an angle of 50 degrees. The shaft from the floor of level 1 to the surface had been completely enclosed by substantial timbering as a protection to the mine and for the safety of the workmen; it is of sufficient width throughout its entire length for a convenient ladderway which has been cased off from the skip track in the other part of the shaft. Good ladders extend from the collar of the shaft at surface down to the second level. In second level a stope had been made 22 by 33 with raise of 11 feet, and work was being vigorously extended towards the winze sunk from level 1. The opening when made will provide good ventilation to the level, and convenience for stoping from above. A 3-inch discharge Cameron pump is used to lift the water to the surface. No additional machinery. A railing must be put on the runway to the sorting table in the rock house; also guards placed around fly-wheel of the engine used for the rock-breaker. The mine is well equipped with first-class machinery, which is kept in good running order. The rock house is substantial and convenient, and all appliances necessary for rapid and safe working is supplied. The place is furnished with a sufficient number of comfortable dwellings for the resident families, and a school room was being fitted up which would also be used for religious services on Sabbath and Sunday School."

Second visit.

The Stobie mine was revisited July 23rd and the work carefully examined. No work since the previous visit had been done in the open pit, or level 1. Stoping in level 2 had extended the extreme length of 100 feet, making an addition since last entry of 67 feet and in width of 16 feet, making the total 38 feet with a raise of 40 feet, being an addition of 29 feet. The extreme distances have been measured, and as the stope has a slope upraise there remains underneath within the boundary a very large body of ore to be removed. The winze sunk from the first level now connects with level 2, giving good ventilation, and shows a thickness of the roof of level 2 of 30 feet. A 4-inch discharge Cameron pump is now used in level 2 to keep the mine free from water. Also a pump has been placed at the

small lake three-quarters of a mile distant and pipe laid therefrom to the mine to insure a full supply of water should the small stream near the rock house at any time prove insufficient to supply the quantity required for use A large quantity of wood was on hand from which car-loads were being sent over daily to Copper Cliff. The daily output of the mine was 180 tons, and a total working force of 80 hands employed, 55 of whom were on underground work. As the winze was being frequently used, I directed that the entrance thereto in the first level be refitted and guards placed around it as a protection from danger. Instructions were also given to have the hillside of the open pit fenced around and all unused test pits and openings fenced or covered. In all other respects I found the mine and outside works in a safe and satisfactory condition.

Extent of workings at end of the year

On the 5th day of January the Captain writes: "Our work has chiefly been confined to the bottom of the mine. North of the shaft (level 2) we have an opening 150 feet long, with an average height of 42 feet and width of 31 feet. Also an opening 51 feet long, 30 feet high and 31 feet wide. The total length of these openings on this side of the shaft is 201 feet. South of the shaft we have an opening 40 feet long, 58 feet wide and 20 feet high. We have started to sink the shaft and a winze down with the shaft for the purpose of ventilation in the bottom of the mine. We have also started a drift north in the first level, below the tunnel."

The ore taken from the Stobie is of lower grade than some obtained from the other mines; yet from the almost unlimited quantity it may be considered one of the Company's best properties.

Evans Mine.

Work in the Evans mine had been re-commenced but a few days previous to my visit (May 21st), when eighty men were employed in and about the property. The mine had been standing idle for a considerable length of time and had nearly filled with water, which had to be taken out and the necessary refitting completed for work. The shaft was in a good condition, all defective places having been repaired, and the walls had been recently scaled. The hoist and all its connections with the machinery above were working smoothly. Work was being done in the open pit and in levels 1, 3, 4 and 5, but to such a limited extent that no measurements were made. Very little ore had been taken from the mine until within the past few days, which had reached 150 tons at this date. The output would be increased as work progressed. The mine was revisited July 22nd and an equal force of men were found to employed as previously reported; from 50 to 60 were on underground work. About 180 tons of ore were removed daily, crushed, screened, sorted and conveyed by railway to the roast yard at Copper Cliff. But little new ground had been opened up, as the work was confined chiefly to removing the bodies of ore remaining from the former workings. Accurate measurements were not easily obtained, but the approximate is as follows:

Measurements.

The open pit which had been sunk to the depth of the floor of level 2 had an additional extension in the northwest part, say 20 by 40 feet, and from the surface down 25 feet; no additional work had been done in that part of levels 1 and 2 included in the open pit work. In level 3 an additional

20 feet extension had been made north of the shaft, and 10 feet west of the shaft, with no additional upraise. On the north side of the shaft a Cameron pump of 4-inch discharge lifts the water to the surface. A varying force is employed in this level, but only two men were working on each shift at this date. In level 4 there was an additional stope north of 10 feet. There was no additional upraise, but an underfoot stope of the floor of level 4 had extended down 10 feet to level 5, and an opening made between these levels of 30 by 30 feet. It was intended to stope out the entire floor of level 4 to level 5, excepting a large pillar next to the shaft which will be left for support. All rock broken down was being raised from level 5. The two levels will be joined as one in level 5. A Worthington pump of 4-inch discharge lifts the water to the sump under the pump in level 3. A reserve Knowles pump is kept on hand in this level, to be used if required. I was informed that the walls were carefully examined and scaled as the work proceeds, and to all appearance they were safe at this date. Guards were placed at all entrances to the shaft, and gates or coverings were in use in each level. No new machinery had been added. Railings were placed around the exposed part and all parts were in good running order. Good fencing was placed around the open pit.

In answer to my inquiry of recent date the captain informed me that work at the mine had been closed since December 24th, and on account of the inflow of water no additional measurements could be made.

Trill Nickel Mining and Manufacturing Co., Limited.

Inez Mine.

The Inez mine, a new name given to an old property, is located on lot 8 in the fifth concession of Drury, five miles north of Worthington station, on the Sault Ste. Marie branch of the C P. R. The property was formerly owned by the Drury Nickel Co., which has been recently reorganized under the Ontario Statute and is now known as the Trill Nickel Mining and Manufacturing Co, Limited. Its capital stock is $1,000,000, in 100,000 shares of $10 each The office is at the mine and the post office at Worthington. The officers are : President, R. P. Travers, who is also managing director and treasurer ; Thomas Travers, Vice-President, who resides at the mine and has charge of the work ; Thomas B. Kiely, secretary ; Directors, Wm. Fennell, John Lamson, Wm. Lamson and John Dwyer. Work was opened up near the middle of the lot by the former Company early in 1891. It consisted in opening pit No. 1 to the depth of 30 feet, length 60 feet, and width 30 feet ; also sinking a shaft 8 by 12 feet from the floor of the open pit to a depth of 60 feet. No. 2 pit was opened 40 feet in length, 80 feet in width, and 30 feet deep. From these workings 3,500 tons of ore were obtained and reduced to matte. A smelter constructed by the same Company was furnished with one water-jacketed furnace of 60 tons capacity in 24 hours ; two boilers 120 h. p. each, English make ; engine for hoist, 35 h. p ; engine rock house, 35 h. p. ; engine for smelter, 30 h. p. ; engine for machine and pug mill, 25 h. p. ; engine for compressor, 75 h. p. ; engine for converter, 60 h. p. ; engine auxiliary when required ; Blake rock crusher with capacity of 200 tons in 24 hours and screen attached ; two Baker blowers, No. 5½ ; Dean pumps, No. 12 and No. 7 ; Knowles pump, No. 7 ; Northey duplex, No. 4 ; Worthington, No. 3 ; three converters ; two drums attached to hoist ; portable hoist with engine attached, 20 h. p. ; six rock drills, two Rands and four Ingersoll ;

Former works and plant.

lathe and drill press; two air receivers, 6 by 26 feet and 5 by 16 feet; heater attached to boiler, 3 by 12 feet; portable boiler, 15 h. p.; engine for blowers, 30 h. p.; a set of Cornish rolls; complete laboratory; saw mill with boiler 40 h. p. and engine 35 h. p.; shingle mill, planer and jointer. The smelter building is 60 by 60 feet, with metal house attached to the east side 40 by 40 feet, and engine room and machine shop attached to the west side 20 by 35 feet; also attached on the southwest corner a ganister building 20 by 30 feet; coke shed, 20 by 120 feet; laboratory and warehouse, 20 by 30 feet, two stories; compressor and boiler house, 30 by 72 feet; rock house, 24 by 24 feet, elevation, 50 feet; shaft house, 14 by 14 feet, elevation 54 feet, with hoisting appendages; powder house, distant from the mine 300 feet, and covered with earth; blacksmith shop, 18 by 20 feet; boarding house, 24 by 40 feet, two stories and basement, and store attached, 20 by 24 feet, with dwelling apartment above; sleeping house, 20 by 40 feet, two stories; dwelling house and office, 20 by 60 feet, three stories; eighteen dwellings for workmen; saw mill building, 20 by 60 feet, two stories, containing the shingle mill, planer and jointer; school house, 20 by 20 feet; log barn, 30 by 60 feet; frame barn, 18 by 24 feet. Buildings.

Work had been suspended for about two years, and was resumed by the new Company on 20th of May last with a small and varying force which was increased to 38 hands at the date of my visit. Twelve were working in the mine and the others employed in the rock house, on the roast yard, and in refitting the smelter and some parts of the mine. A new skip track had been laid from the floor of No. 1 pit to the top of the rock house with varying incline of 75, 65 and 60 degrees. A one-ton skip with 100 feet of new steel cable is used for hoisting. An additional underfoot stope in this pit had gone down 12 feet for 35 feet in length and 30 feet in width. The shaft extending downward about 50 feet below the floor of the pit was being timbered and a good ladder-way was being cased off from the hoisting part of the shaft and the skip track extended down to the bottom. The work would be completed in about a week, when an additional force of men would be employed in taking out ore. A new hoisting frame was put up for No. 2 pit in which an underhand stope had gone down 12 feet, extending in length 40 feet and in width 30 feet; the total elevation from the floor of the stope to the roof was 45 feet, with 15 feet thickness of rock remaining to surface. A bucket holding half a ton with seven-eighths steel cable lifts the ore. About 40 tons of ore were mined daily, crushed sorted, and removed to the roast beds. Three thousand tons of ore were on hand, roasted or in process of roasting; 500 cords of wool had been cut and 350 brought in for immediate use. Timbers were being delivered along the road as per contract for a trolley-way from Worthington station to the mine, across which coke, coal, and other supplies would be taken to the mine, and matte shipped from the smelter to the station. It was expected to be ready for use within two or three months. Work resumed by the new Company

Instructions were given to have a sheath put over the piston rod on the air receiver, and the fly wheels and other exposed parts of the machinery, and the stair-ways properly protected with railings; also that all unused shafts and open pits be fenced or covered.

MICA AND TALC.

Occurrences in Nipissing district.

A claim lying in block 24, district of Nipissing, 10 miles by wagon-road from the railway, is owned by the Spanish River Nickel Mining Company. The president of the Company in a recent note states that the quartz occurs in very large ridges with the felspar carrying the mica in large crystals. "Several of these deposits have been found on the contact, three of which were located by ourselves. Indications are that we have a mica formation surpassing other districts, as the deposit follows the border of the Laurentian in the granite for forty miles almost direct east and west." In August, when on the train (Soo Branch) of which Mr. Dreany is conductor, he handed me a very fine specimen of this pure white mica. Some of the crystals I was told would cut fully 8 inches square.

In a recent letter Mr. Dreany also states that the talc property in the southeast corner of May township, Algoma district, owned by the Spanish River Talc and Nickel Company, of which he is president, will commence active operations soon, as the Company is now being backed up by interested Montreal and Quebec capitalists. A shaft on the property has been sunk 40 feet. The vein from 2½ feet at surface has widened to 11 feet at this depth. About 75 tons of talc is now on the dump

GYPSUM.

Paris Mine.

The Paris mine, which is one mile and a quarter east of the town of Paris, was visited December 8th and work was progressing in the same drift as previously reported. Work had been suspended since March last and only resumed in the middle of November. Three men were employed by contract taking out from five to six tons of plaster daily, which were hauled to the town and ground in the Company's plaster mill. The drift had been enlarged in places and newly timbered where needed, which rendered it more convenient for going in and out of the mine, and was apparently in a safe condition. The place of working was 220 feet from the mouth of the drift, where the layer of plaster was being blasted out for a few feet of width, and the waste rock was used for building up abutments as support to the roof. Strong stull timbers were also used for the same purpose where stone could not be supplied to make the place of working safe. The former workings had extended back for fully 300 feet from the entrance of the drift, exposing a continuous layer of ore from four to five feet in thickness of 160 feet in length, and the limit had not yet been reached. The place of working is about 120 feet beneath the surface of the hill. It was stated that mining would be continued for a considerable length of time.

Products of gypsum.

The mill was confined to the manufacturing of alabastine at the time of my visit, which was being put up in small packages for the market, large shipments of which are made to Australia. A considerable quantity of plaster brought from the Excelsior mine near Cayuga was on hand, soon to be manufactured into alabastine, calcined plaster and other products prepared in the mill. This is the only mill in the Province manufacturing at the present time calcined plaster.

R. E. Hare, foreman of the mill, informed me that there had been a largely increased demand during the year for the various products manufactured. The mill has excellent water power from the Grand river, and 7 or 8 hands are employed when in full operation. Mr. J. M. Wheeler of Paris is the Company's general manager.

Excelsior Mine.

The Excelsior gypsum mine, three miles east of the town of Cayuga, is easy of access, being near the public road, over which the ore is hauled to the Cayuga station for shipment. Mr. John Nelles, who has had charge of the mine for the past 15 years, does the mining by contract, hiring men by the day to assist him. The Adamant Manufacturing and Mining Company of Syracuse, New York, who purchased the property six years ago, have recently entered into a contract to supply the Alabastine Company of Paris with 2,000 tons of ore. The plaster is of excellent quality, a considerable part being pure white. Three men were engaged in mining at the time of my visit, December 14th, and were taking out about six tons per day. About 1,000 tons had been mined during the year. The drift starting about the middle of the lot, which comprises 65 acres, is run in at an incline of one foot to ten in a northerly direction. It reaches the layer of plaster at a distance of 150 yards, and is continued more easterly the further distance of 200 yards to the present place of working. The drifts gradually vary both in direction and length as the work progresses. As the ore layer is removed the open space is walled up with waste rock as support to the roof, only a few feet space remaining for a tramway and convenience of working. A large area has been worked over during the several past years. It is estimated however that at least 35 acres of ore yet remain on the lot, and Mr. Nelles informed me that the bed extends easterly beyond the boundary for two miles. At the place of working the ore is from 50 to 60 feet below the surface. The drift is kept in a good state of repair, new timbers being supplied when needed, and the roof is frequently examined and any loose rock removed. The mine is provided with four air shafts, which serve the triple purpose of ventilation, safety to the workmen as a way of exit from the mine in the event of any disaster to the drift closing it, and also over two of them windmills are placed working efficient pumps with $1\frac{1}{2}$-inch discharge, keeping the mine free from water. One shaft, 4 by 4 feet, is located 175 yards from the entrance and near the drift, and No. 2 at 300 yards from the entrance of the drift. Both are cased up and provided with ladder-way, and are frequently used by the workmen for going in and out of the mine. The other two are in the older workings of the mine, some 300 yards apart, but easy of access. No accidents have ever occurred in the mine

A [illegible] use for [illegible] in the [illegible]

Recently some fine specimens in large blocks have been taken from the mine and sent on to the Toronto Marble Company to be used in place of marble. It is stated that these blocks of plaster were subjected to a chemical process which hardens them, rendering them impervious to the weather and permits taking on a beautiful finish. Should this new use of plaster prove a success, it undoubtedly will result in greatly extending mining operations in the principal mines now worked and opening up new ones which are known to contain extensive beds of ore. A Dixon hand-power drill has been pur-

chased in Denver, Col., and brought to the mine to be used in taking out the blocks of plaster; if found practicable several of them will be used. The blocks wanted are to be of large size, of from one to two tons weight, and in the event of a large quantity of them being required the mine will be refitted by enlarging the drift, timbering it anew and laying down iron rails over the tramway.

Martindale Mine.

The Martindale gypsum mine is situated on lots 53 and 54 of the River Range, south side of Grand river, near the village of York, five miles east of the town of Caledonia, and two miles north of York station on the Buffalo and Goderich Railway. It comprises 195 acres held by mineral rights. It is one of the oldest plaster locations on the Grand river, having been worked for nearly fifty years. It has been owned and worked by Mr. Thomas Martindale for the past thirty years, with an average annual output of 2,000 tons of plaster until within ten years, since which a lesser quantity has been raised. In 1895 200 tons were taken out, and last year 400 tons. An area of between 25 and 30 acres has been mined over, and apparently the remaining field of ore is extensive. The layer of plaster is from 40 to 50 feet beneath the surface and averages four feet in thickness; the quality is excellent, a large part being pure white. The bed follows to some extent the undulations of the surface. A drift of sufficient size for a horse tramway starts near the river and extends southward with a slight incline for a distance of over 600 yards to the present place of working. At the date of my inspection two men were engaged by contract taking out about five tons daily. It is hauled over the tramway to the mouth of the drift and dumped into piles, and afterwards hauled by teams to Caledonia and ground for land use. From the entrance of the drift the ore body is reached at a distance of 300 feet, and through the clay part the drift is supported by posts and planking at the sides and lagging overhead, and for the most part is in a safe condition. The few places requiring additional support or renewing with timber were pointed out to the contractor and instructions given to have the repairs done. The additional part of the drift is chiefly supported by leaving pillars of plaster and building up stone abutments of the waste rock as the work progresses. The rock overhead for most part of the way appeared firm; in some places it required trimming and some timber supports. At the place of working as the breast of the plaster layer is shot down it is followed with timbering or walling up with stone pillars to render it secure. Both the tamping rod and pricker being used in charging holes for blasting were iron, which I directed should forthwith be changed for copper or material not dangerous, and the attention of the contractor was called to section 66 of the Mines Act. I directed that an air shaft be sunk from the surface to the present place of working, or near thereto, not less than 4 by 4 feet, properly cased and provided with ladders as means of escape should any serious mishap occur to the long drift to prevent going out through it. It will also secure good ventilation to the mine and afford convenience to the workmen to go in or out near the work. The shaft is required to be completed not later than the first day of March next, and to be constantly kept in safe state for use.

Instructions

NATURAL GAS.

Late in the year I called on Mr. R. E. Walker of Caledonia to ascertain the condition of the gas wells in that town, of which a short report was given the previous year. He has furnished the following note :

" As promised I give you a short statement of Caledonia gas wells. I can speak more fully of my own well. This year I find an increased flow, with a rock pressure of 200 lb. I have now on— Caledonia Gas Wells

2 furnaces, earning for month of November			$12 00
3 heaters,	"	"	8 00
12 stove burners	"	"	33 00
46 house lights	"	"	11 00
2 soldering furnaces	"	"	1 50
Earnings of well for the month			$65 50

"The flow has been steady, but during a very cold spell the rock pressure has been pulled down to 120 lb. One reason why I believe my well is holding out is that I do not draw gas and let the water in. Our three company wells are not doing nearly so well at present, there only being for the month of November—

1 furnace	$ 8 00
17 stoves	51 00
Making a total of	$59 00

" The wells have been troubled with water rising in them. The Company had five furnaces and about twenty stoves on last winter, and so weakened their supply. A dividend was declared last winter of 33 per cent. The rock pressure is about 200 lb., and is pulled down sometimes to 100 lb. Dr. Foster's well hardly supplies his own wants. No fresh wells have been put down this year."

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